

Driving Innovation Through the Information Infrastructure

SPRING 2011



Intel IT's Virtualization and Cloud Journey

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Agenda

- Level-Set on Cloud Computing
- Role of Cloud Computing at Intel IT
- Intel's Cloud Strategy, Roadmap, and Architecture
- What's Next
- Q&A

What is Cloud Computing?



Google

define:Cloud computing

- Internet-based computing
- a technology used to access services ...
- The use of a Web service such as Flickr, Google Docs, Jing ...
- On-demand self service Internet infrastructure where pay as you go and use only what you need ...
- A new generation of computing that **uses distant servers for data storage and management ...**
- Refers to accessing computing resources that are **typically owned and operated by a third party provider (public)**
- May refer to a company's own network (private)
- **Shared** resources, software and information are provided to computers and other devices **on-demand**, like a public utility
 - ... evolves from grid computing and provides on-demand resource provisioning

Many Viewpoints and Definitions Exist Across Industry



What the Cloud Means to Intel IT

Delivering a highly available computing environment where secure services and data are delivered on-demand to authenticated devices and users utilizing a shared, elastic infrastructure that concurrently supports multiple tenants

Essential Attributes¹

On-Demand Self-Service Broad Network Access Resource Pooling Rapid Elasticity Measured Service Shared Multiple Tenants

Service Models

Software as a Service Platform as a Service Infrastructure as a Service

Delivery Models

Public Private Hybrid

¹These attributes been adapted from National Institute of Standards and Technology, and reflects the key characteristics and business drivers for cloud computing within the Intel IT organization

Cloud Plays a Key Role for Intel IT

Our Strategy is to Grow the Cloud from the Inside Out

Building a secure, highly available, agile efficient enterprise private cloud Applying key experience from our Design Grid computing environment Using a combination of public and private cloud infrastructure as we evolve

Our Strategy is Based on ...

- Continuous Monitoring of Business Drivers
- Evolution of an Architectural Roadmap
- Strong Cloud-Client Integration
- Systematic Application Sourcing

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Intel IT Vital Statistics

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6,300 IT employees 56 global sites

80,100 Intel employees 143 sites, 62 countries

91 Data Centers

~100,000 servers; 458,694 square feet

>105,000 Devices

>90K PCs (80%+ mobile), >20,000 Handhelds



Identified Intel as a company that exemplifies the demand-driven Ideal for today's supply chain.





Intel IT Data Center Overview



Mandate: Enable Efficient Growth



Cloud Strategy: Core Components

- Business Drivers
- Architectural Roadmap
- Cloud-Client Integration
- Application Sourcing



Cloud Computing Business Drivers

Intel IT Enterprise Private Cloud Architecture

Business Benefits

Efficiency

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Security

Availability

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High-Level IT Strategies and Goals

- Accelerate virtualization to create a multiple tenant O/E environment
- Deploy new, retire old servers to improve energy efficiency
- Drive higher utilization via resource pools and consolidation
- Measure services for VM utilization, health and IT capacity management
- Improve provisioning time from days to hours with on-demand self service
- Automate workflows to enable consistency, agility and elasticity
- Streamline business processes with on-demand self-service portal
- **Opportunistic use** of federated public cloud services, when applicable

Utilize and build on existing security infrastructure and safeguards
Protect Intel IP, data and differentiated business processes
Provide secure access to authenticated devices and users

- $\boldsymbol{\cdot}$ Deliver high availability and drive increased resiliency for all IT services
- Use a consistent **disaster recovery** architecture for critical applications
- Adopt advanced technologies for highest availability on mission-critical apps



Why Emphasize Cloud Now?

The business demands of agility, efficiency, availability and security are not new



"On-demand self-service allows IT Infrastructure to get out of the way of the business so we can up level IT and be a strategic business partner"

Das Kamhout (Cloud Solution Architect, Intel IT)



IT's Cloud Strategy & Roadmap



Grow our Cloud from the Inside Out



Enterprise Private Cloud Overview

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On-Demand Self-Service Of Elastic Infrastructure Built Primarily On Server Virtualization

Application Sourcing Decision Tree

Does Application meet <u>any</u> of these criteria

- Confidential/Restricted Secret/Top Secret data
- Mission Critical or Tier 1 application
- Integrates with mission-critical workflow/app
- · Provides a differentiating business capability
- Network bandwidth and latency dependency

Assess Workflow complexity/customization

- Industry standard workflow
- Minimal customization

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 At natural re-engineering point in lifecycle (Poor Health Scores - M&A – Greenfield)



External Public Cloud

Software as a Service (SaaS) Applications

• Examples: Staffing, Benefits, Expense, Social Media/Web 2.0, ...

Host Vast Majority of our Applications in our Enterprise Private Cloud. Selectively use Public Cloud for non differentiated IT services

Internal Private Cloud

Infrastructure and Platform

as a Service (IaaS / PaaS)

Examples: Enterprise Applications,

Messaging & Collaboration, Primary Data Storage, User Profile Management ...

Applications

d Application Sourcing Strategy

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Selectively use Public Cloud for non differentiated IT services

Host Vast Majority of our Applications in our Private Cloud

External Cloud Software as a Service (SaaS) Applications

Staffing

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- Benefits
- Expense
- Social Media/ Web 2.0
- Travel
- Stock



- Other SaaS Applications
- Hosted Web
 Applications

Internal Cloud Infrastructure and Platform as a Service (IaaS / PaaS) Applications

- Messaging and
 Collaboration Infrastructure
- Enterprise Applications
- User Profile Management
- Hosted Web Applications
- Primary Data Storage



- Productivity Applications
- Security and Virtual Machine (VM) Policy Control
- Applications Delivery and Management
- Workspace/Container Provisioning and Management

By building a **private cloud**, we can deliver on the **benefits of public clouds**, such as increased **agility and efficiency**, **without the risks** associated with **exposing Intel's sensitive applications and data** outside the firewall.

Sourcing Balances TCO, Performance and Security



2010 Cloud Results



42% of Server OSs Virtualized

- 18% Virtual at end of 2009
- 75% End Goal

3 hours Time to Provision a Virtual Server

- 100+ days for physical
- <4 days for virtual (manual)
- <3 hrs for On Demand VMs



- 60% technically limited in 2009
- Only 25% technically limited at end of 2010

Intel IT succeeded in bringing Cloud capabilities to our virtual O/E Infrastructure



Pervasive Virtualization

• 2010 Enabled capabilities:

- Mission Critical Features Clustering, Database Mirroring, and Web
- Load Balancers
- Mega VMs <128GB
- Externally Facing Application Servers Enclave/DMZ
- Approx 60-65% TAM 'Operationally Available'



Majority of technical limiters removed in 2010, focus shifts to operational readiness, security, and removing last remaining technical hurdles...

Cloud Implementation Takes Time

"We're making changes to support the legacy application environment while implementing a new secure, agile, efficient, service-oriented environment. Our mindset is to provision services, not servers"

Das Kamhout (Cloud Solution Architect, Intel IT)

Have to Balance Short Term Priorities and Long Term Goals

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Short Term Priorities / Projects

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- Make Virtualization Pervasive
- Shift Provisioning From Weeks to Hours

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Experience from Design Computing

What We Did (2006-2008)

In 2006, Intel IT implemented a Design Grid computing solution inside our environment that featured both laas and PaaS attributes



Offloading Design Workloads to Virtual Linux Clusters

Estimated \$200M Net Benefit over 8 years⁺

In 2007, Intel IT moved to a proactive server refresh model in Design to support compute growth with energy efficient hardware







Experience from Design Computing

What We Learned (2006-2008)

Key IT Lessons Learned

- Abstracted the hardware
- Abstracted the location
- Deployed Service Management
- Accelerated Service Provisioning
- Proved Value of Grid + Refresh
- Gained Business Agility

80% Utilization and an Estimated USD \$200M Value¹



Proving That An IaaS Approach Worked For Design, Intel IT Built The Case For Replicating These Efforts Across O/E

¹Source: Intel IT internal analysis. Savings from Design Grid expected to deliver net present value over 8 years. Intel IT white paper: "Intel IT Data Center Solutions: Strategies to Improve Efficiency" <u>http://communities.intel.com/docs/DOC-4220</u>



Intel Enterprise Private Cloud Program Accelerate Server Virtualization



Source: Intel IT. January 2010. Intel IT paper on virtualization implementation. http://download.intel.com/it/pdf/Implementing_Expanding_Virtualized_Environment.pdf



On-Demand Service Delivery





Automation and On Demand Self Service drove aggregate VM TTM reductions

Dev Service: 307 On-Demand VMs delivered, 198 EOL'd at end of lease

Automated 'Operator' Provisioning

Prod On Demand 'customer' facing interface

Dramatic Agility Improvements

- Physical: > 100 days
- Virtual Mid 2010: 14 days
- Virtual 'Manual' End 2010: <4 days
- Virtual On Demand < 3 hrs

On Demand is here and capturing increasing % of all VM provisions...

On-Demand Self Service



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Automated Web and/or Database Provisioning Activities



Key Results: Efficiency + Agility





Evaluated Many Technologies and Usages

Cloud Service Delivery Models

Security Considerations

New Companion Devices



p://download.intel.com/it/pdf/Better_Together_RichClientsPCs_and_CloudComputing.pd p://download.intel.com/it/pdf/Evaluating_Thin_Client_Security.pdf p://download.intel.com/it/pdf/Increasing_Productivity_with_Mobile_PCs.pdf



Motive for On-Demand Self-Service Portal

- Consumers are encumbered by existing server landing business processes
- No end-to-end automated solution
- Process and infrastructure differences among sites

- Service delivery lead times remain tied to legacy business processes
- No transparency into end-to-end service support and delivery



On-Demand Self-Service Portal

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Virtual Machine (VM) Equivalent to a Physical Server

VM Options	Target Environment	CPU (up to)	Memory (up to)	Disk (up to)	Density
Small	App, Web, Basic Servers	1 vCPU	2GB	100GB	22:1
Medium	SQL dB Servers and Java Applications	2 vCPU	4GB	200GB	11:1
Large	App Stacked, Large App, Super Servers	4 vCPU	8GB	500GB	5:1



Managed Cloud Capability Stack





Cloud Capability Phasing Over Time

	Near-term	Mid-term	Longer-term
Business Transformation	On-demand self-service Measured Services	Automated workflows Capacity Planning Transformation	IT BI solutions for enabling business decisions
Compute, Resiliency	Default to virtualized Automated VM restart	Cross-site Disaster Recovery MCA-Recovery	Lockstep VMs, Near native virtualization performance
Storage	Thin-provisioning, Data Duplication Elimination Consolidated Backup/Restore	Storage resource pools & QoS Incremental forever Backups and Recovery	Solid-state data-center Continuous Data Protection
Network	10 GbE Distributed Virtual Switch	Unified Fabric (compute, storage)	40 GbE
Security	Non-production VMs in DMZ Event and Access Monitoring	Secure Live VM migration VM Isolation	Public cloud federation Pervasive encryption
Management	Infra. Inventory and Health Basic BI: Capacity / Perf / health Automated Patch / Provision	Auto end to end Lifecycle Mgmt	Cloud brokerage & federation Private-Public Cloud Live Migration
Datacenter	Energy savings via virtualization	Cross Platform Power and Data Center Management	Near-linear power scaling PUE Improvements
Clients	Client Virtualization, MB-PC plus Handhelds	Expanded small form-factor support	Client Aware Services: optimized across a range of clients



Key Lessons from Intel IT's Cloud





Cloud Terminology

Understand what you are talking about

IT Staff Sponsorship

Clear Business Goals. Multi-year commitment.

IT-Business Partnerships

Business Process Changes are pervasive

Multi-Year Effort



Set Short Term Priorities

Make Pervasive Virtualization + Faster Provisioning

Manage With Data

P2V ROI, Measured Services, BI collection, Server Sizing



Looking To The Future

- Conceptual Architecture Guides Innovation
- Hosting Automation / Measured Services
 - Enable Device Independent Computing

Technology Phasing (Data Center + Client)



Thank You

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Backup

terprise Private Cloud Implementation

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An Enterprise Private Cloud Architecture and Implementation Roadmap

enterprise private cloud include:

reduced provisioning times.

Chris Peters Increased agility, including significantly

The private cloud is a shared multi-tenant environment built on a highly efficient, automated, and virtualized infrastructure.

Intel IT has defined an architecture and implementation roadmap for a private enterprise cloud designed to increase agility and IT efficiency.

Sudp Chaha Sudp Chaha Sudp Chaha Other legelements of the cloud influence integration of the subscription of the subscription provided as a service and a seff-anticle port of the subscription of the subscription of the subscription provided as a service and a seff-anticle port of the subscription of the subscription of the subscription of the decimal of the subscription of the subscription integration of the subscription integration of the subscription integration of the subscription integration of the subscription of the subscription of the subscription integration of the subscription of the subscr

Principal Engineer, Intel IT

Manager, Intel

The private cloud is a shared multi-tenant Greater efficiency, including environment built on a highly efficient. energy savings, due to better automated, and virtualized infrastructure. resource utilization. Other key elements of the cloud include · High availability without additional standardized application platforms provided cost, by taking advantage of as a service and a self-service portal that enhancements to industry-standard enables business groups to request and hardware and software manage capacity for their applications. Improved capacity management, During the design of our private cloud taking advantage of new business architecture, we were able to take advantage intelligence tools of the extensive experience gained while

Because of the extensive scope of this initiative, we plan to deliver private cloud capabilities in phases over the next three or more years. As we add these capabilities, we expect that the cloud will become capable of hosting highly demanding, mission-critical business applications. Comprehensive 8 page whitepaper on the Intel IT's enterprise private cloud architecture

- Business Benefits
- Key Capabilities
- Implementation Roadmap
- Technology Phasing
- Application Sourcing

Intel IT's Cloud Computing Initiative

Intel IT's cloud computing strategy is to build an enterprise private cloud that delivers several benefits to Intel improving **agility**, **efficiency** and **availability** of secured, managed **services**

(intel)

White Paper Intel Information Technology Computer Manufacturing Cloud Computing

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Developing an Enterprise Cloud Computing Strategy

Cloud computing is a significant timel with the posterial to increase agility and lower costs. Today, however, security risks, immature technology, and other concerns prevent widequreed interprise adoption of external clouds, into IIT is developing a strategy based on growing the cloud from the incide out, the tails advantage of software as a service (Sea) and rich enfortsurture as a service (Sea) implementation, wheneve possible, and we are building an internal cloud-computing environment. Our internal environment delivers many of the banefits of clouds and positions us to use external clouds in the future, as upplier offering meture and beniets to enterprise adoption are overcome.

Hong LI Jeff Sedayao, Jay Hahn-Steichen, Ed Jimison, Catherine Spence, and Sudip Chahal, Intel Corporation January 2009 Implemented On-Demand Self Service

- Clarified Terminology
- Identified Business Drivers
- Applied Key Lessons from Design
- Established "To-Be" Architecture
- Gained Executive Support
- Engaged Business Teams & Users
- Implementation Roadmap

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Intel IT Cloud Terminology

Cloud Computing Taxonomy



Figure 1. Intel's cloud computing taxonomy classifies the breadth of existing cloud technologies.

Cloud Computing is About IT Services

http://download.intel.com/it/pdf/Cloud_Compute_Taxonomy.pdf





On-Demand Self-Service PoC



