Slide 1

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Driving Efficiency. Control. Choice.

The Journey to Private Cloud

Le Hung
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Slide 2

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EMC Corporation: At a Glance

Revenues (2008):	**$14.9 billion**
Net Income (2008):	**$1.4 billion**
Employees (end Q2 2009 worldwide):	**≈ 41,500**
Countries where EMC does business:	**> 80**
R&D Investment (2009 estimate):	**$1.5 billion**
Total Cash and Investments (end Q2 2009):	**$10 billion**
Operating Cash Flow (1H 2009):	**$1.44 billion**
Free Cash Flow (1H 2009):	**$1.1 billion**
Market Capitalization (August 3, 2009):	**> $30 billion**
Founded:	**1979**

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Global Market Presence: Worldwide Market Share

Storage Hardware H1 2009

External Disk Storage		External RAID		Networked Storage (NAS, Open, & iSCSI SAN)	
EMC	21.1%	EMC	22.5%	EMC	26.0%
IBM	13.1%	IBM	13.7%	IBM	12.1%
HP	11.4%	HP	9.8%	NetApp	11.8%
Dell	9.8%	NetApp	9.5%	HP	11.0%
NetApp	8.9%	HDS	9.1%	Dell	9.1%
HDS	8.5%	Dell	8.6%	HDS	7.8%
Sun	4.9%	Sun	5.0%	Sun	4.8%
EMC/Dell*	25.8%	EMC/Dell*	27.5%	EMC/Dell*	30.8%

Storage Software H1 2009

Total Storage SW		Replication SW		Device Mgmt SW		Infrastructure SW	
EMC	22.1%	NetApp	31.0%	EMC	63.9%	Symantec	30.7%
Symantec	18.7%	EMC	30.6%	HDS	9.4%	EMC	25.1%
IBM	11.9%	IBM	8.5%	HP	8.4%	NetApp	14.2%
NetApp	8.4%	HDS	6.6%	Sun	4.2%	IBM	13.0%
CA	4.2%	Sun	5.1%	IBM	3.5%	HDS	4.6%
HP	3.6%						

Data Protection & Recovery Software		Storage Mgmt Software		Archive and HSM Software	
Symantec	31.9%	EMC	30.8%	IBM	18.5%
IBM	13.6%	IBM	17.3%	Symantec	15.1%
EMC	11.9%	CA	15.4%	Autonomy	11.1%
CA	6.1%	HP	4.3%	EMC	5.6%
HP	4.2%	HDS	3.1%	CommVault	2.5%

Quarterly Tracker Sep 2009; IDC Worldwide Quarterly Storage Software Tracker, Sep 2009.
...et segment. *Combines EMC's revenue with Dell's Dell/EMC CLARiiON revenue.

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Background of Cloud Computing

Cloud Computing
Part of grid computing + most of utility computing + more
New paradigm of computing

Utility Computing
Virtualization improves resource utilization and reduces CAPEX, OPEX
Offer metered service

Grid Computing
Parallel computing
Clustered node, kept ready to handle distributed workload
Small workload causes unutilized/under-utilized node

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What Analysts say about Cloud

"The cloud is IT as a Service. Delivered by IT resources that are independent of location."
— 451 Group

"Cloud computing is a style of computing where massively scalable IT-related capabilities are provided 'as a service' across the internet to multiple external customers."
— Gartner

"A pool of abstracted, highly scalable, and managed infrastructure capable of hosting end-customer applications and billed by consumption."
— Forrester Research

"Cloud is a model for enabling convenient, on-demand network access to shared pool of configurable computing resources (e.g. networks, servers, storage, applications) that can be rapidly provisioned & released with minimal management effort or service provider interaction."
— NIST

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My Organization Needs New Computing Resources

- **Option 1** – Invest and expand organization's infrastructure
  - Keep adding servers, storage, and connectivity
  - components, HVAC systems
- **Option 2 –** Pool and virtualize existing resources
  - Increase resource utilization beyond physical limit
- **Option 3** – Leverage cloud computing infrastructure
  - Extend virtualization beyond enterprise datacenter
  - Hire computing resources from cloud service provider
    - Pay-as-you-go

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Cloud Services
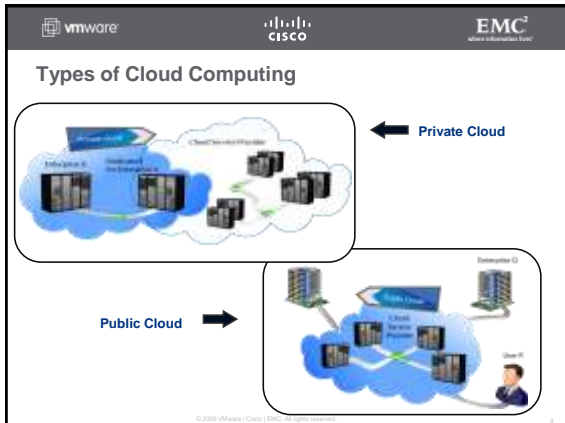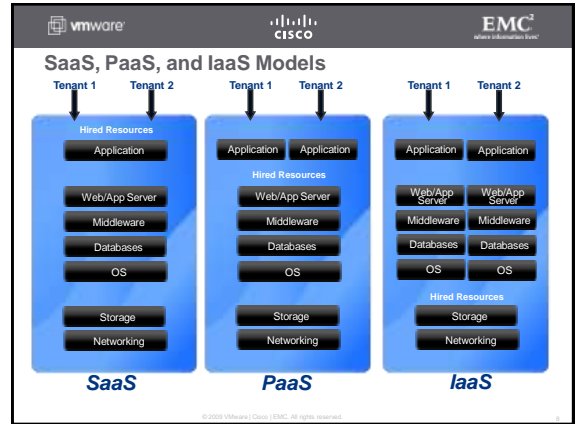
Cloud computing enables cloud services

Characteristics:
- Offsite, may be provided by third-party vendor
- Accessed via the Internet
- Minimal/no IT skills to implement cloud services
- Underlying technology is transparent to the user
- Web browser or web service API based access
- Dedicated or shared resources
- Measured service

Cloud service offerings classified into three models
- SaaS, PaaS, IaaS

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SaaS, PaaS, and IaaS Models

| Tenant 1 | Tenant 2 | Tenant 1 | Tenant 2 | Tenant 1 | Tenant 2 |

SaaS
- Hired Resources
- Application
- Web/App Server
- Middleware
- Databases
- OS
- Storage
- Networking

PaaS
- Application | Application
- Hired Resources
- Web/App Server
- Middleware
- Databases
- OS
- Storage
- Networking

IaaS
- Application | Application
- Web/App Server | Web/App Server
- Middleware | Middleware
- Databases | Databases
- OS | OS
- Hired Resources
- Storage
- Networking

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Types of Cloud Computing

Private Cloud

Public Cloud

Slide 4

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Cloud Benefits

Increased capability

Improved performance

Lower cost

Reduced risk

Flexible scaling

No infrastructure management complexity

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Cloud Backup Service Decho Mozy

mozyhome
Online Backup

mozypro
Online Backup

2GB absolutely free forever
Unlimited personal backup
Mac and Windows support

Secure online backup for businesses
Server and network share support
Web-based administration

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Driving Efficiency, Control, Choice

VCE

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Imagine….

Virtual Computing Environment

Cisco and EMC, together with VMware, form **Virtual Computing Environment**, an unprecedented coalition to accelerate pervasive virtualization and private cloud infrastructures; Cisco-EMC joint venture to speed customer adoption.

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News Announcement – Imagine the Power of Three

The Virtual Computing Environment coalition. Cisco and EMC, together with VMware, have committed to extensive and on-going collaboration to lead the journey to pervasive virtualization and private cloud with technology innovation, business partnership, venture investments and partner ecosystem leverage.

Technology Innovations
Vblock Infrastructure Packages. Integrated best-of-breed packages from Cisco and EMC, together with VMware – engineered, tested, and validated to deliver revolutionary TCO and pervasive virtualization at scale in today's most demanding use cases.

Integrated Pre-Sales, Services and Support
Vblock Unified Customer Engagement. Dedicated pre-sales, professional services and single support experience to provide a seamless, end-to-end customer experience.

Solutions Venture and Investment
Acadia. A Cisco-EMC joint venture to build, operate, and transfer Vblock infrastructure to organizations who want to accelerate their journey – *available Q1 CY2010.*

Partner Ecosystem Leverage
Vblock Partner Ecosystem. A select group of partners, growing over time, which augment, sell and deliver Virtual Computing Environment solutions to enable the journey to pervasive virtualization and private cloud.
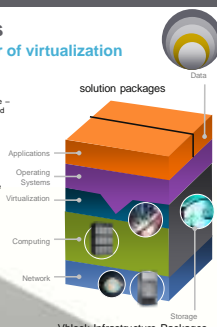
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Vblock Infrastructure Packages
Managing risk while delivering the power of virtualization

What is it:
The combined best-of-breed technologies from Cisco and EMC, together with VMware – pre-integrated, tested, and validated to redefine the foundation of datacenter virtualized infrastructure.

How it works:
Rather than buying and assembling individual components, now acquire validated Vblock Infrastructure Packages direct or from partners with a seamless services and support experience.

Benefits:
•Accelerating the journey to pervasive virtualization and private cloud computing while lowering risk and operating expenses
•Customer assets (operating systems, applications, and data) are on-boarded as solution packages

solution packages

Data
Applications
Operating Systems
Virtualization
Computing
Network
Storage
Vblock Infrastructure Packages

Imagine the power of three …
Redefining the foundation of data center infrastructure

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vBlock: Pre-Integrated Best of Breed

Automate	Unified Infrastructure Mgr UCS Manager NaviSphere	CMDB, ServiceDesk Unified Infrastructure Mgr ServiceDesk, UCS Mgr NaviSphere	CMDB, Smarts, DPA Unified Infrastructure Mgr UCS Mgr, ECC,
Protect	Avamar RecoverPoint	RecoverPoint Replication Manager Data Loss Prevention RAM & RKM	Envision, Security Mgr SRDF, Data Domain Site Recovery Mgr RAM & RKM
Networks	Nexus 1,000 MDS 9221	Nexus 5,000 MDS 9221	Nexus 5,000 MDS 9506
Storage	CLARiiON CX4-240	CLARiiON CX4-480	Symmetrix VMAX SE/ME
Server	UCS C-Class vSphere Enterprise plus	UCS B-Class 2-4 chassis vSphere Enterprise plus	UCS B-Class 4-8 chassis vSphere Enterprise plus
Virtual Machines	300-800	800-3,000	3,000-6,000

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Vblock Infrastructure Packages
A New Way of Delivering IT

Benefits:

Accelerate the journey to pervasive virtualization and private cloud computing while lowering risk and operating expenses

Ensure security and minimize risk with certification paths

Support and manage Service Level Agreements
– Resource metering and reporting
– Configuration and provisioning
– Resource utilization

Vblock is a validated platform that enables seamless extension of the environment

Virtualization | Compute | Storage | Network

Secure, Extensible, SLA-driven, Infrastructure

Slide 6:
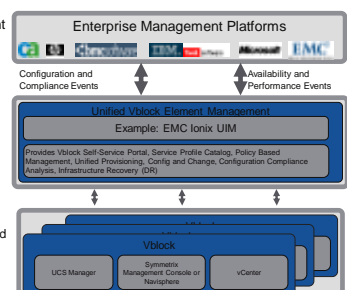
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Unified Vblock Element Management
Single Point of Management, Extensible Integration Framework

Unified Vblock Management Interface
Consolidated view into all Vblock infrastructure
Single integration point

IT self-service portal
Mini service catalog and dashboard for self-provisioning

Policy-based management
Fine-grained tracking, traceability, reproducibility
System-wide compliance and remediation

Automated discovery and deployment

Enterprise Management Platforms

Configuration and Compliance Events | Availability and Performance Events

Unified Vblock Element Management

Example: EMC Ionix UIM

Provides Vblock Self-Service Portal, Service Profile Catalog, Policy Based Management, Unified Provisioning, Config and Change, Configuration Compliance Analysis, Infrastructure Recovery (DR)

Vblock

UCS Manager | Symmetrix Management Console or Navisphere | vCenter

Slide 1: VCE's Seamless Support Experience

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VCE's Seamless Support Experience

Unified inter-company collaboration tool

Joint problem re-creation labs

Single experience for onsite and remote support

Cross-company, cross-product-trained support experts

Cooperative Engineering Groups

seamless support experience

Common metrics and alignment
Shared problem resolution and escalation processes
Documented processes via best practice Support Implementation Plan

Imagine the power of three …
Industry's first single support experience

Slide 2: First Step to Cloud & EMC optimization product

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Driving Efficiency, Control, Choice

First Step to Cloud & EMC optimization product
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Slide 3: First Step To Cloud: Virtualization

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First Step To Cloud: Virtualization

Optimize existing resources – **virtualize the data center**
– Combine resources together and abstract them to create a virtual world
– Virtualization of application and infrastructure

Extend the virtualization beyond a data center
– Pool all your 'federated' resources from multiple sites
– That creates what we could call an *"internal cloud"*

APP OS

Virtualized Infrastructure

Data Center Location 1

Data Center Location 2

Slide 4: Virtualization on Server Layer

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Virtualization on Server Layer

Physical Environments

20 TB
• 24 CPUs
• 24 NICs
• 48 GB of memory

Virtual Environments

VMware   VMware

20 TB
• 8 CPUs
• 8 NICs
• 16 GB of memory

Utilization the System Resource

Slide 5: Fibre Channel over Ethernet (FCoE)

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Fibre Channel over Ethernet (FCoE)
Consolidate server I/O connections

FC HBA
FC HBA
NIC-10GigE
NIC-10GigE
NIC-10GigE

FC SAN
Ethernet LAN

CNA-10GigE
CNA-10GigE

FCoE
Connectrix NEX 5000

FC SAN
Ethernet LAN

FCoE deployed with 10 GigE
CNAs replace NICs and HBAs
FCoE switch attaches to LAN
Servers attach via ISLs from the FCoE switch to SAN

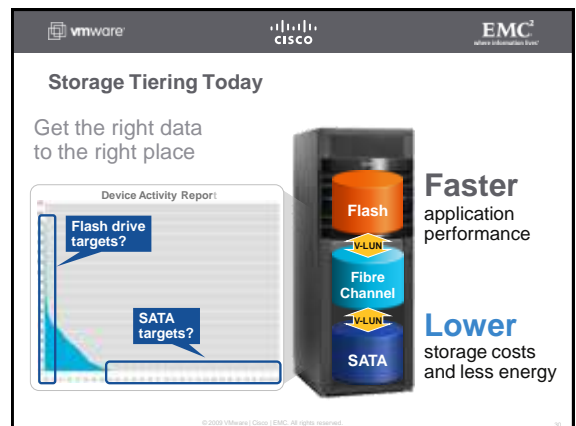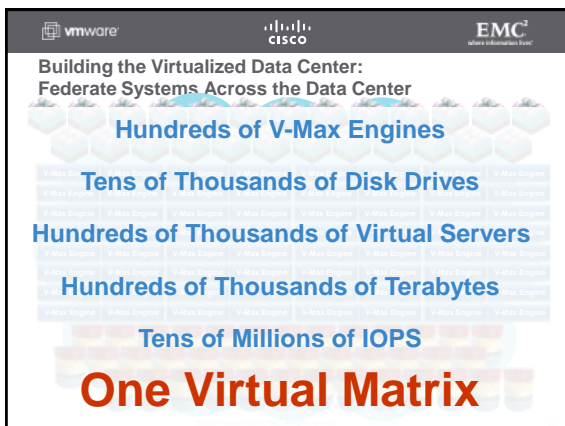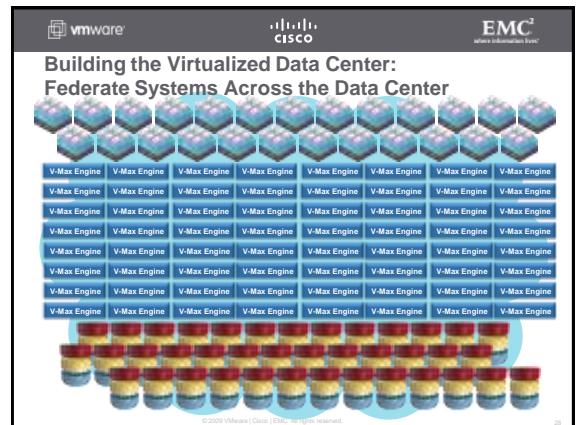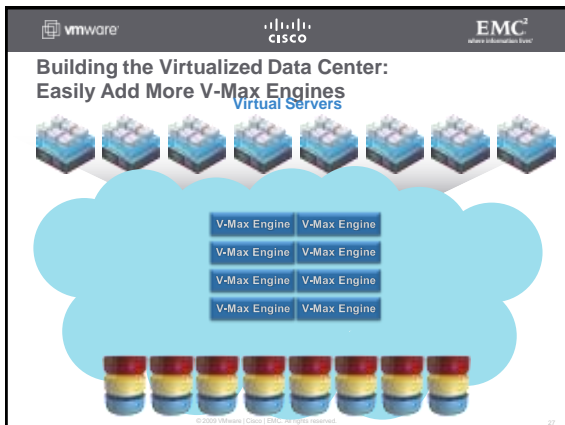**FCoE simplifies server, network, and storage infrastructure**

Slide 6: Virtualization on Storage Layer

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Virtualization on Storage Layer

Storage Pool

Provision Storage Capacity with SLA anytime, anywhere

V-Max

Storage for Virtual Data Center

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Symmetrix V-Max Engine Building Block

Single, flexible building block

Symmetrix V-Max Engine

Front End | Back End — Host & Disk Ports — Core Core Core Core / Core Core Core Core — Global Memory | CPU Complex → CPU Complex | Global Memory — Virtual Matrix Interface — A B

Front End | Back End — Host & Disk Ports — Core Core Core Core / Core Core Core Core — Virtual Matrix Interface — A B

Integrates industry standard components with unique Symmetrix technologies and capabilities

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Building the Virtualized Data Center: Easily Add More V-Max Engines

Virtual Servers

V-Max Engine	V-Max Engine
V-Max Engine	V-Max Engine
V-Max Engine	V-Max Engine
V-Max Engine	V-Max Engine

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Building the Virtualized Data Center: Federate Systems Across the Data Center

V-Max Engine (grid of many V-Max Engines)

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Building the Virtualized Data Center: Federate Systems Across the Data Center

Hundreds of V-Max Engines

Tens of Thousands of Disk Drives

Hundreds of Thousands of Virtual Servers

Hundreds of Thousands of Terabytes

Tens of Millions of IOPS

One Virtual Matrix

---

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Storage Tiering Today

Get the right data to the right place

Device Activity Report

Flash drive targets?

SATA targets?

Flash — V-LUN — Fibre Channel — V-LUN — SATA

Faster application performance

Lower storage costs and less energy

Slide 1

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Lower Costs and Optimize Service Levels

Acquisition $

17%

528 146 GB 15K Fibre Channel drives

8 200 GB Flash drives
104 400 GB 10K Fibre Channel drives
32 1 TB SATA drives

65 TB   65 TB

17 percent lower storage costs
And reduced maintenance and software costs

38 percent more drive IOPS
And more aligned with workloads

32 percent less power and cooling
And more efficient use of space

384 fewer drives (>70% Reduction)
144 Flash drives plus Fibre Channel drives plus SATA drives versus 528 Fibre Channel drives

Slide 2

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Simplify Management of Virtual Environments

Management Abstraction Enables Ease, Speed, and Automation

VMware infrastructure	Quickly provision resources on demand	Auto-provisioning, Virtual Provisioning
Distributed Resource Scheduler, VMotion	Nondisruptive mobility of applications and data	FAST, Virtual LUNs
High Availability, vStorage VMFS	Policy-based load balancing across physical resources	PowerPath
vCenter Server	Centralized, automated management, reporting, and control	Ionix ControlCenter and VMware vCenter Server Plug-in

Slide 3

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Easy, Quick, and Automated Storage Provisioning for Virtual Servers with a Single Action

Traditional Mapping and Masking

HBA

Port A DEV DEV DEV
Port B DEV DEV DEV
Port C DEV DEV DEV
Port D DEV DEV DEV

40 Individual Masking Operations
5 ESX servers x 2 HBAs x 4 storage ports

~160 clicks to complete
Includes initial configuration and repeated for every change or add

Auto-provisioning Groups

HBA

Port A DEV DEV DEV
Port B DEV DEV DEV
Port C DEV DEV DEV
Port D DEV DEV DEV

Single Setup to Build and Associate Groups

15 clicks to complete
Simplifies initial configurations and all future changes and additions

Slide 4

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Driving Efficiency, Control, Choice

Avamar & DataDomain
Next Generation of Backup & Restore Solution

Slide 5

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De-Duplication: How it Works

❶ Break data into atom (sub-file, variable-length segments of data)
❷ Send and store each atom only once
❸ backup repository

At the source—Deduplication before data is transported across the network
At the target—Assures coordinated deduplication across sites, servers, and over time
Granular—Small, variable-length sub-file segments guarantee most effective deduplication

Slide 6

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Where Can Data Deduplication Occur?

Source (Avamar)
Client software agents identify repeated sub-file data segments at the source

Only new, unique segments are transferred across the network and stored to disk

Shorter backup window, reduces daily impact on physical/virtual infrastructure

Target (Data Domain)
Backup application sends native data to a target storage device

Data is deduplicated once it reaches the target – during or after the backup

Found in VTLs or LAN B2D appliances

Transparency to backup application offers users a "plug and play" experience

Deduplication at Source

Network

Deduplication at Target

Network

Slide 1

Avamar: Real-World Results
Avamar daily full backups versus traditional daily full backups

Data Type	Amount of Primary Data Backed Up	Amount of Data Moved Daily
Windows file systems	3,573 GB	6.1 GB
Mix of Windows, Linux, and UNIX file systems	5,097 GB	11.7 GB
Engineering files on NAS (NDMP backups)	3,265 GB	24.2 GB
Mix of 20% databases, 80% file systems (Windows and UNIX)	9,583 GB	80.0 GB
Mix of Linux file systems and databases	7,831 GB	104.2 GB

Source: EMC

While results will vary by data type and mix, Avamar can dramatically improve backup performance and efficiency

Slide 2

Avamar's Innovative Architecture

Avamar Server
- Verified checkpoint
- Parity across storage nodes
- Utility and spare node

U.S. Patent No. 6,826,711

Redundant Array of Independent Nodes (RAIN) architecture
- Each server node includes CPU, memory, and internal disk storage
- Provides high availability and fault tolerance across nodes

Grid architecture for online scalability and performance

Daily Avamar server integrity checks

Data recoverability verified daily

RAID protection from disk failures

Available for Avamar software and Avamar Data Store

Slide 3

Avamar Supported Operating Systems and Applications

Client operating systems supported
- Microsoft Windows Server 2003 Standard and Enterprise
- Microsoft Windows 2000 Server and Advanced Server
- Microsoft Windows Server 2008
- Microsoft Windows XP, XP Professional, Vista
- Red Hat Linux 9.0
- Red Hat Enterprise Linux (RHEL) 3.0, 4.0, 5.0
- Solaris 8, 9, 10
- SUSE Linux Enterprise Server 8.2, 9, 10
- IBM AIX 5.2, 5.3, 6.1
- HP-UX 11.0, 11iV1, 11iV2, 11iV3
- Mac OS X 10.4x, 10.5x
- NetWare 6.5
- Free BSD 6.2
- Novell Storage Services (NSS) OES 2
- SCO UNIX 7.1.3

Application modules
- Microsoft Office SharePoint Server 2007
- Microsoft Exchange 2000, 2003, 2007
- Microsoft SQL Server 7.0, 2000, 2005, 2008
- Oracle 9i, 10g, 10gR2, 11g
- IBM DB2 8.2.x, 9.5
- NDMP (EMC Celerra with DART 5.5, 5.6)
- NDMP (NetApp Data ONTAP 6.5, 7.0.4, 7.0.5, 7.0.6, 7.1x. 7.2)
- IBM Lotus Domino

VMware infrastructure
- VMware ESX server 3.0.x, 3.5, 3i
- vSphere 4
- ESX client operating system-certified using RHEL 4 client (support within virtual machines depends on VMware support of client operating system)

No charge for client agents or application modules!

Slide 4

VMware Backup Challenges

Virtualization changes server, application, and information paradigm… backup must evolve to deliver even greater consolidation and value

Old Paradigm
Physical environment: Low overall server utilization and plenty of bandwidth for backup

Server A Server B Server C

20% resource utilization

New Paradigm
Virtual environment: High overall server utilization and little bandwidth for backup

ESX server
Hardware
Shared physical resources

Virtual Server A Virtual Server B Virtual Server C

80% resource utilization

Slide 5

Data Domain Basics
Easy integration with existing environment

Control Tier

Backup & Archive Applications
- EMC
- symantec.
- commvault
- Tivoli software
- BakBone
- vizioncore

CIFS, NFS, NDMP, OpenStorage
Ethernet
VTL over FC

Target Tier
DD880 Appliance

Replication

DR Tier
DD880 Appliance

4U
2 - 6 ports
10 and 1 Gb Ethernet; 4 Gb Fibre Channel
RAID-6
5.4 to 71 TB usable capacity with shelves
1 TB or 500 GB 7.2k rpm SATA HDD in shelf
File system
NVRAM
N+1 fans and redundant, hot-plug power supplies

Slide 6

Industry's Most Scalable Inline Deduplication Systems

DD500 Appliance Series
DD600 Appliance Series
DD690g Gateway
DD880
DD120 Remote Office Appliance
DDX Array Series
Up to 16 Controllers
Internal or External Storage

Software Options: OpenStorage, VTL, Replicator and Retention Lock

	DD120	DD510	DD530	DD565	DD660	DD690	DD880	DDX Array
Speed (GB/hr)	300	435	540	1.1 TB/hr	2 TB/hr	2.7 TB/hr	5.4 TB/hr	86.4 TB/hr
Logical Cap. (TB)	7-18	55-135	110-285	320-810	520-1.31 PB	710-1.7 PB	1.4-3.5 PB	22.6-56.7 PB
Raw Cap. (TB)	.750	Up to 3.75	Up to 7.5	Up to 23.5	Up to 36	Up to 48	Up to 96	Up to 1.5 PB
Usable Cap. (TB)	.373	Up to 2.7	Up to 5.7	Up to 16.2	Up to 26.1	Up to 35.3	Up to 71	Up to 1.13 PB