

EMC IT's JOURNEY TO THE PRIVATE CLOUD: BACKUP AND RECOVERY SYSTEMS

A series exploring how EMC IT is architecting for the future and our progress toward offering IT as a Service to the business

Abstract

This white paper focuses on EMC IT's experiences in positioning itself to deliver Backup and Recovery as a Service to its business units as part of its Infrastructure as a Service initiatives. Using EMC's cutting-edge products, EMC IT has leveraged deduplication, archiving, and automation as key strategies in implementing its next-generation backup and archiving technologies.

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Table of Contents

Executive summary	4
Introduction	4
Audience.....	5
Background	5
Backup and Recovery as a Service	6
Data deduplication	7
Source-based deduplication using Avamar.....	9
Use Case 1: Remote office backup.....	9
Use Case 2: File systems and virtual machine backup within the data center	11
Use Case 3: End-user (desktop and laptop) backup.....	11
Target-based data deduplication using Data Domain	12
Use Case: EMC SourceOne backup using Data Domain.....	12
Use Case: Microsoft SQL Server database backup using Data Domain.....	13
Data archiving	13
File system archiving using EMC File Management Appliance	13
Email archiving using SourceOne	14
Automation	16
Use Case: Replication Manager in Microsoft Exchange	18
Conclusion	18
References	19

Executive summary

EMC IT is using a structured and phased approach on its journey to the private cloud. One of the phases in this journey involves streamlining and optimizing the company's backup and recovery processes to simplify and automate operational control, and drive cost and operational efficiencies through *Backup and Recovery as a Service*.

In today's 24x7 global business environment, the challenge has gone beyond duplicating and archiving data offline to protecting live production data as it flows through an organization—across multiple applications, operating systems, networks, clients, servers, and storage. Faced with expanding data volumes, increasing IT complexity, rising costs, and demanding recovery and compliance objectives, EMC IT is committed to delivering next-generation backup, recovery, and archiving technologies that address these demands.

To avoid interdependencies and overlap among emerging hardware and software technologies, users require an integrated approach that goes beyond fragmented, point- and product-based solutions that typically increase complexity and require more floor space, energy, and administrative resources to scale upward. With cloud computing, EMC IT can provide a cohesive set of on-demand, storage delivery services that help transform IT by delivering IT agility, accelerating time-to-market for new applications, and reducing investment costs. EMC's latest data deduplication, data archiving, and automation technologies further this objective. They support a “never back up the same data twice” principle, which helps reduce storage footprints and optimize network bandwidth for shorter backup windows. They facilitate better protection and improved access to information. They also make it possible to automate much of the process, which results in significant time and cost savings.

This white paper explores the methodologies and emerging technologies that EMC IT is using for its backup, automation, and archiving solutions on its journey to the private cloud. This is one of a series of white papers describing EMC IT's journey to move toward a private cloud-based IT infrastructure. To learn more about this initiative, read the white paper [EMC IT's Journey to the Private Cloud: A Practitioner's Guide](#).

Introduction

With a focus on EMC IT's initiative in providing Backup and Recovery as a Service to its business units, this paper details the steps, processes, best practices, and qualitative and quantitative benefits achieved. It contains the following sections:

- [Background](#)—Provides insight into the technical and business factors surrounding EMC IT's implementation of state-of-the-art backup and recovery solutions.
- [Backup and Recovery as a Service](#)—Describes EMC IT's efforts in furthering its backup, recovery, and archiving initiatives with the goal of offering Backup and Recovery as a Service.

- [Data deduplication](#)—Details EMC IT’s use of EMC Avamar® and Data Domain® deduplication technologies to address exploding data growth through the identification and elimination of redundant data.
- [Data archiving](#)—Covers EMC IT’s email and file system archiving strategies supported by EMC SourceOne™ and EMC File Management Appliance to optimize production and storage capacity, reduce costs, and mitigate risks.
- [Automation](#)—Discusses how EMC IT integrated Ionix™ for IT Operations Intelligence with EMC backup and recovery-related technologies to improve automation and increase efficiency and agility in managing backup and recovery across EMC’s complex IT infrastructure.

Audience

This white paper is intended for IT program managers, IT architects, and IT management, as well as key stakeholders and leadership team members who may be involved in making decisions related to implementing backup and recovery systems within their organization.

Background

EMC Corporation is a large global enterprise with more than 47,000 employees working across 150 locations in over 50 countries. As with any organization of this size, the role of EMC IT in supporting and driving growth is critical to the business. Therefore, EMC IT must ensure a robust infrastructure for managing data and storage, while delivering expeditious and comprehensive support to end users.

With a rising number of global remote sites, exponential growth of data from mailboxes and databases, and higher service-level agreement (SLA) commitments, EMC IT needed to expand backup and recovery capacity and functionality. Yet this had to be carried out without impacting the allocated budget. With this in mind, EMC IT identified the following business challenges:

- **An increased need for storage**—Data generated is no longer restricted to simple, text-based files but also includes large, data-intensive, multi-lingual texts, images, audio, video, and presentations. Storing large amounts of data and quickly recovering them as needed is now imperative.
- **Intensified compliance pressures**—With e-commerce and an increasingly regulated environment, EMC must now store and maintain its information for longer periods of time to meet regulatory and legal obligations.
- **Rising costs**—Rising energy and real estate costs for backup and recovery infrastructure are creating budgetary challenges for EMC IT.

To address these challenges, EMC IT needed to find ways to link and search for related information; prevent repetition of saved data; and develop consistent policies and procedures for backing up information.

Having already embarked on its journey to the private cloud, EMC IT realized that building a next-generation backup and recovery system, designed to address future challenges and facilitate the ability to offer Backup and Recovery as a Service to the company's business units, was an important step in the process. Expected benefits included:

- **Reduced costs**—Leveraging deduplication and archiving to minimize storage capacity requirements would provide more cost-effective and centralized backup and recovery policies.
- **Increased efficiency**—Backup and Recovery as a Service would enable the organization to be dynamically positioned based on the criticality of backup and restore requirements. By removing the inefficiencies of tape-based backup and by leveraging disk-based solutions, data integrity would be enhanced and data restoration accelerated.
- **Automated management**—Using EMC Proven™ technologies for Backup and Recovery as a Service would help meet compliance requirements and reduce the complexity of infrastructure management. This would enable users to orchestrate multiple backup and recovery approaches within a single coherent environment, and manage organizational backup needs from widely dispersed business units. The end result would be an accelerated auditing and business reporting process.

Backup and Recovery as a Service

Businesses are at risk when information is not protected or easily accessible. EMC IT's Backup and Recovery as a Service initiative is focused on:

- Protecting information and preserving all changes to that information for extended periods of time.
- Eliminating slow data backup and recovery, while improving reliability.
- Minimizing IT investments and reducing power costs, while increasing end-user confidence.

EMC IT's next-generation backup and recovery program is founded on the following guiding principles:

- **Simplified management**—Centralizing and standardizing backup and recovery initiatives across EMC for easy troubleshooting and reduced management costs.
- **Policy-based management**—Reducing backup infrastructure to strengthen data protection, refine policies, and implement strategies to optimize backup and recovery services.
- **Faster backups and restores**—Improving the recovery time objectives (RTO), recovery point objectives (RPO), and reliability of backup services by phasing out obsolete, tape-based technologies.

- **Scalable archiving**—Archiving older data on more cost-effective storage systems, without impacting end-user performance.
- **Storage efficiency**—Ensuring that the same data is never backed up twice.
- **Cost-effective solutions**—Minimizing costs with innovative solutions that help avoid new storage purchases.
- **Automation**—Implementing automated alerting, monitoring, and reporting for more effective and proactive incident management.

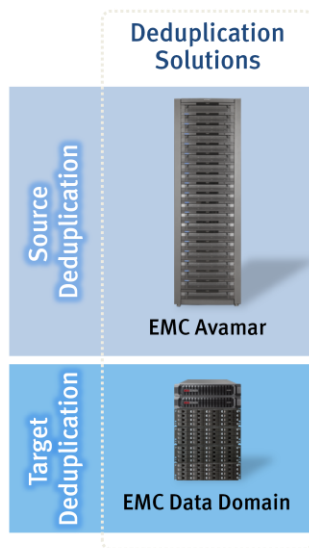
To provide an elastic and scalable backup and recovery service that is efficient, reliable, and easy to provision to business units, the EMC IT Backup and Recovery as a Service initiative is based on three core areas: [data deduplication](#), [data archiving](#), and [automation](#).

Data deduplication

Data deduplication, often called "intelligent compression," is a method of reducing storage needs by eliminating all redundant data, and backing up only the unique changes or additions to the data. This is particularly advantageous in the private cloud environment where data may be backed up to a remote site over the network.

EMC IT's comprehensive approach involves both source-based and target-based deduplication solutions to ensure efficiency and deliver maximum benefits in a variety of use cases and implementation environments.

One of EMC IT's key priorities is to ensure that all data can be reliably stored and easily recovered. Therefore, EMC IT has embraced technologies such as write verification, fault detection, and self-healing. EMC's deduplication goals and projected benefits are shown in Figure 1.



Business goals

- Ensure data is stored and recoverable by using techniques like write verification, fault detection, and self-healing
- Deduplicate backup data to deliver more efficient disk-based, onsite data protection
- Ensure quick recovery to meet customers' service levels

Projected benefits

- Centralized backup, eliminate distributed offsite backups
- Simplified full data recovery
- Reduce the storage footprint
- Perform backup recovery through WAN/LAN
- Reduce administrative costs and simplify data management

Figure 1. EMC IT's two-level approach to data deduplication

To support efforts in this area, EMC IT has deployed three of its best-in-class products for its next-generation backup and recovery solutions.

- [Avamar](#) is a fundamental disk-based backup system that provides distributed deduplication, optimized storage, and simplified restoration procedures.
- [Data Domain](#) is a centralized, highly efficient deduplication storage technology that can be used for any backup or archive application.
- [NetWorker®](#) is unified backup software that seamlessly integrates with Avamar and Data Domain to support all enterprise backup needs.

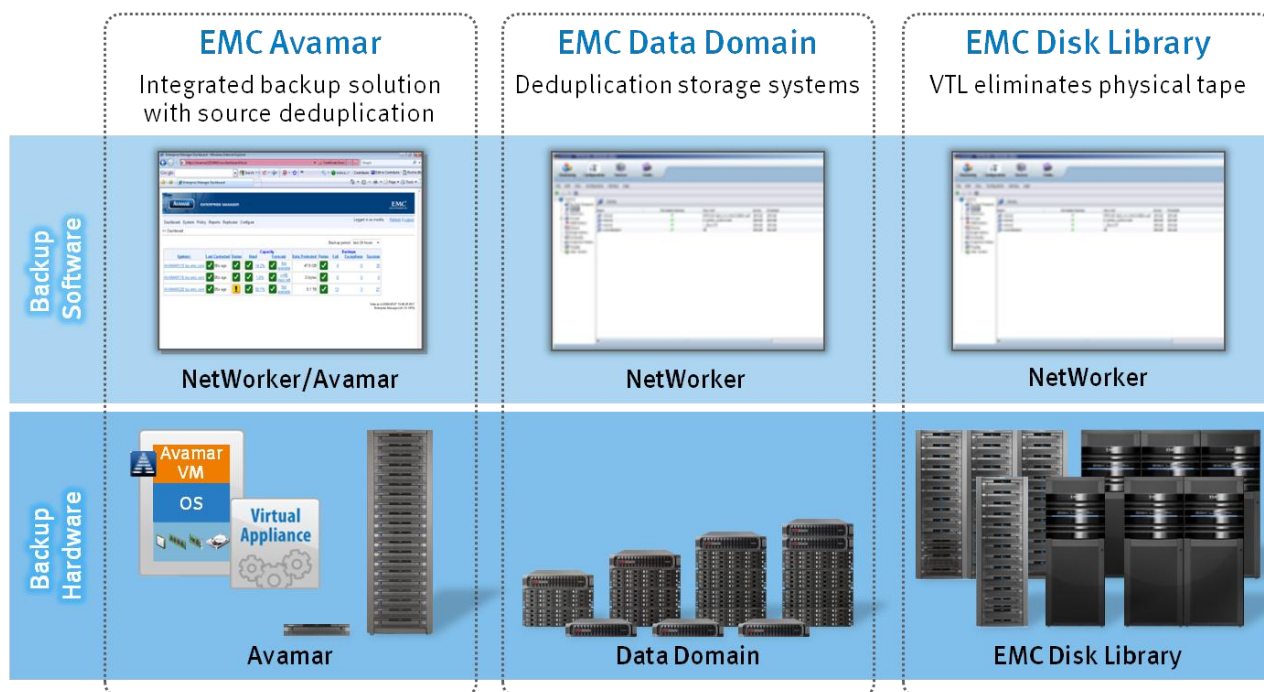


Figure 2. EMC IT backup and recovery systems using Avamar, Data Domain, and NetWorker

Source-based deduplication using Avamar

EMC Avamar, the industry’s leading source-based deduplication solution for environments requiring fast, single-step recoveries, helps effectively manage data growth, complex virtual and remote environments, bandwidth-constrained infrastructures, and NAS file systems.

EMC IT has implemented Avamar in situations that require extensive backup across crowded networks—including those where there is a short backup window, network bandwidth limitations, high commonality, and/or low change rates. Typical examples include laptops and desktops, file systems, virtual machines, remote offices, or small NAS devices. This work has enabled EMC IT to improve backup windows, lessen virtual infrastructure stress, and reduce backup client-server bandwidths.

Details of some of EMC IT’s source-based deduplication use cases and strategies are documented on the following pages.

Use Case 1: Remote office backup

EMC had sub-optimal and inconsistent backup and recovery practices and retention policies at its remote offices. With more than 6,000 backup-related incidents per year, EMC was not only at risk, but the absence of global retention policies and multiple restore steps also led to extended backup and recovery times.

To rectify this situation, EMC IT introduced an Avamar-based deduplication solution designed to be centrally deployed across EMC data centers that would also enable EMC IT to replace end-of-service-life technologies with centralized, tapeless solutions.

In this effort, EMC IT implemented four 18-node Avamar grids (16 data node grids, one utility node, and one spare node) that are strategically located in four data centers across the globe. This implementation covers over 150 offices, including 72 offices in the Americas, 49 offices in Europe and the Middle East, and 28 offices in the Asia-Pacific region.

The new, centralized Avamar-based solution now provides sophisticated control and administration of backup and recovery activities that support consistent data retention policies throughout the organization.

Figure 3 depicts the implementation and representations in the U.S.

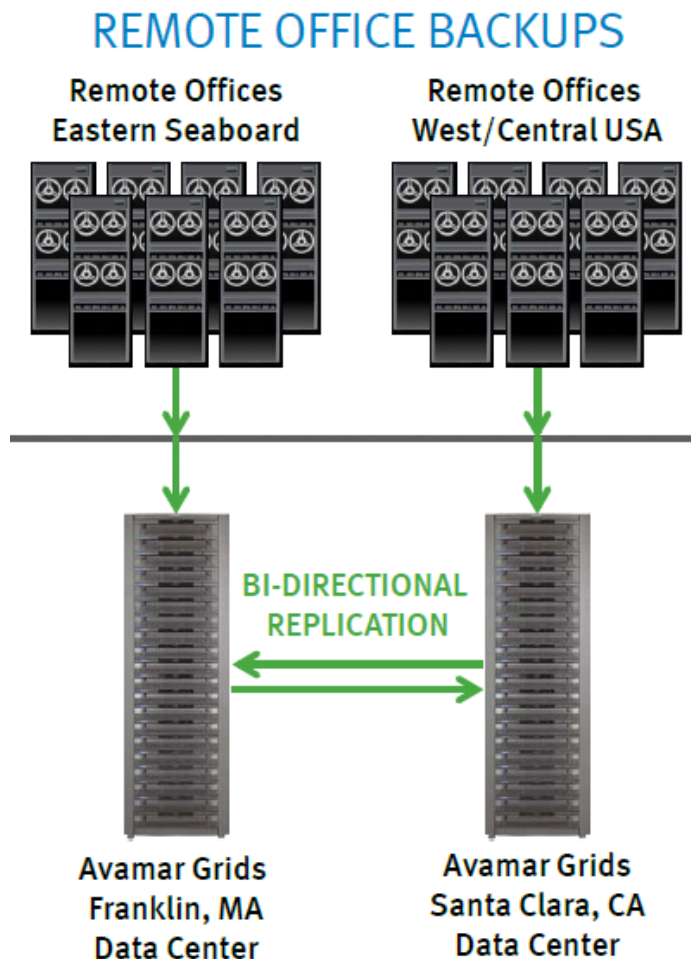


Figure 3. Remote office backup implementation using Avamar in the U.S.

By implementing this solution, EMC IT has realized more than \$1 million in cost savings, a 40 percent reduction in backup storage space, a 95 percent reduction in backup data, and a 90 percent reduction in backup time. Additionally, by eliminating tape-based infrastructure, backup personnel can now focus their time on other vital roles. Overall, there has been a dramatic reduction in incidents by 98 percent.

Use Case 2: File systems and virtual machine backup within the data center

Virtual machines are core to EMC IT's journey to the private cloud. However, having many virtual machines running across servers potentially increases the amount of data that needs to be backed up as well as network bandwidth consumed. Given the limited backup capacity to virtual machines, EMC IT implemented an Avamar-based solution integrated with EMC NetWorker to provide source-based deduplication and backup within the data center.

Through this effort, EMC IT has achieved a deduplication ratio of 95 percent, and reduced the data storage requirement from 1,232 TB to 64 TB. All tape infrastructures have been eliminated, and the number of management points has been cut from 137 to 7. Required power consumption has decreased by 50 percent, and the reduced amount of data in the pipeline has significantly lessened network traffic. As a result of this initiative, the growth rate of storage has been significantly curtailed.

Table 1 shows storage statistics before and after deduplication implementations.

Table 1. File system and virtual machine backup deduplication statistics

	Before	After
Primary data storage	183 TB	183 TB
Monthly full backup	183 TB	N/A
Daily incremental	7.6 TB	371 GB
90-day retention	1,232 TB	64 TB

Use Case 3: End-user (desktop and laptop) backup

EMC IT manages more than 40,000 desktops and laptops globally. Of those, only 11 percent had some enterprise-provided backup, which meant that the majority of end-user clients were without adequate protection. Providing data protection, disaster recovery, and business continuity within this environment was imperative.

End-user requirements included the following:

- The backup and recovery solution had to be easy for end users to set up and use.
- Backup and recovery operations had to be fully automated, fast, and efficient.
- The solution had to have an on-demand, self-service option that was convenient and nondisruptive and that provided a high degree of security and reliability.

EMC IT's requirements were:

- The backup and recovery solution needed to be cost-effective, meet end-user requisites, and support optimized bandwidth and storage.
- It had to protect business-critical data and enable enterprise-level integration.
- The solution had to support scalable client management and centralized administration.

Addressing all requirements and challenges, EMC IT successfully used source-based deduplication supported by Avamar to enable end-user backup (desktop and laptop) for EMC employees across worldwide locations. Based on the device configurations, time zone, and CPU resource utilization of individual machines, this EMC IT developed service provides:

- A standard lightweight Avamar client for Microsoft® Windows®.
- Self-service restore via an intuitive end-user interface.
- An enhanced security model specific to a desktop or laptop use case.
- Standard Avamar deduplication backup software.

This solution now allows user data to be securely backed up in a standard, SLA-driven, and simple manner. Implementing this solution has helped EMC IT replace the informal methods used by employees, and significantly improve the consistency of the operation.

Target-based data deduplication using Data Domain

Faced with rapid data growth, a complex and increased data center footprint, and escalating power costs, EMC needed a better way to manage data backup and backup activities that were resource-intensive. EMC IT employed Data Domain-based backup and recovery solutions to specifically address the challenges of backing up extensive or voluminous data.

EMC IT successfully implemented Data Domain to facilitate deduplication of all data, without the need to change existing infrastructure or backup and archiving applications. Data Domain systems deliver high-throughput, scalable deduplication storage for the distributed enterprise, and provide a network-efficient and cost-effective solution for disaster recovery, remote-office data protection, and tape consolidation. Data Domain uses target-based deduplication, which means that the data is deduplicated inline as it reaches the target—without having to drastically alter the backup application, which can continue sending native data to the storage device.

Data Domain is preferred when both high-volume and high-capacity deduplication needs to seamlessly integrate with the existing backup infrastructure. This is particularly applicable when backing up Oracle, SAP, large ROBO, large NAS, Microsoft Exchange, and long-term data preservation-based applications. Data Domain's ability to remove network congestion and transparently integrate with existing infrastructure is invaluable in a private cloud-based IT environment.

Details of some of EMC IT's target-based deduplication use cases and strategies are documented on the following pages.

Use Case: EMC SourceOne backup using Data Domain

Data Domain-based backup solutions have been installed for backing up EMC SourceOne, which represents 20 days of full backups, with 15-day retention. These backups consisted of mixed types of data including structured data such as Microsoft

SQL Server® and unstructured data such as file indexes. The result after the backup was a significantly reduced footprint, with no decrease in backup throughput or data recoverability. In the process, 115 TB of data has been protected using 7.5 TB of storage space. EMC IT has achieved a compression ratio of 15:1 while the earlier average compression ratio was 1.5:1.

Use Case: Microsoft SQL Server database backup using Data Domain

The SQL Server database backup represents 20 days of mixed backups (full, incremental, and differential). The SQL databases have 30 days retention while OS/file share data has 90 days.

Through the use of Data Domain technology, 55.2 TB of data has been protected using 7.5 TB of storage space. The compression ratio of 15:1 has been achieved through the NetWorker Module for SQL Server, as compared to the earlier average compression ratio of 1.5:1.

EMC IT is also implementing Data Domain solutions for NAS, Microsoft Exchange, and Oracle.

Data archiving

EMC IT's comprehensive data archiving solution enables the management of key information assets throughout the information lifecycle, while providing business units with a platform that is flexible and scalable. The data archiving solution has the ability to handle enormous data growth, as well as provide quick and easy access to archived data content, which is imperative in a cloud-based IT environment. This delivers savings on the primary storage as well as cost efficiencies gained through a reduced amount of backup storage.

EMC IT has also been developing data archiving solutions to provide proactive Data Archiving as a Service to business units for EMC File Management Appliance solutions (for file system archiving) and EMC SourceOne (for email archiving).

File system archiving using EMC File Management Appliance

Faced with exploding growth in data and increased file densities, EMC needed efficient file systems archiving methods.

Requiring a solution capable of discovering files suited for archiving based on parameters such as file access attributes, file types, and metadata, EMC IT was able to enhance its archiving strategy using the EMC File Management Appliance. This solution captures the trace of end-to-end migration paths for each file. EMC file system archiving, now supported by the EMC File Management Appliance, manages rapidly growing data by automatically migrating inactive data to more cost-effective, self-managed archive storage. The result is improved productivity and compliance as well as faster and more reliable recovery.

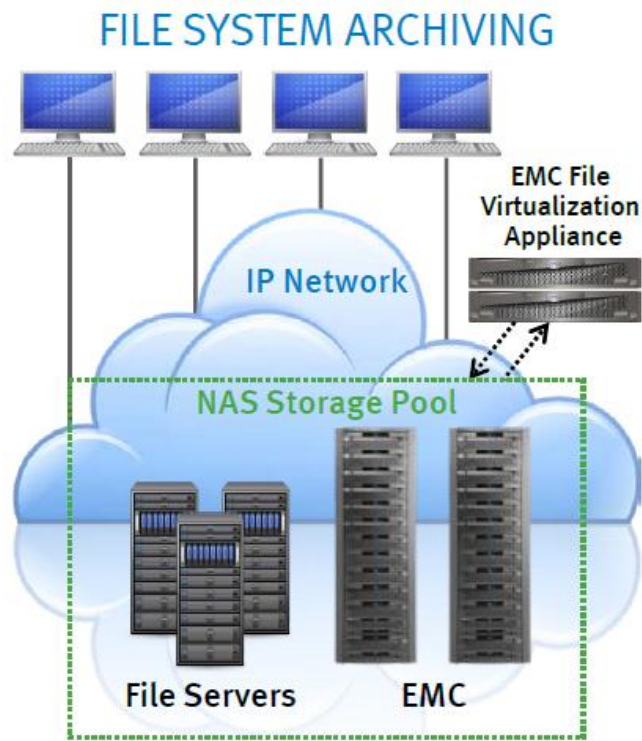


Figure 4. File system archiving using the EMC File Management Appliance

By defining storage, archival, and retention policies as well as automating the workflow for the file discovery, migration, and archiving process, EMC IT has reduced the total cost of archiving. Additionally, the ability to centrally manage files throughout the information lifecycle has helped EMC IT simplify management of the archiving process.

One of the key benefits of archiving is that the file systems are now optimized for growth. This new archiving system ensures a single instance, and includes data retention capabilities that have helped EMC IT reduce the need for primary NAS storage. By eliminating file access filtering, avoiding unnecessary metadata indexing, and facilitating the full portability of the archived data, EMC IT has built a solution that is both scalable and flexible. As a result, it has greatly enhanced productivity and ensured content authenticity and integrity.

By eliminating the need to purchase over 1.2 TB of data, EMC IT has realized cost avoidance savings of about \$42 million over a five-year period. Reducing the backup capacity required for primary storage has also provided significant savings.

Email archiving using SourceOne

EMC's organic and inorganic growth has led to an exponential growth in the number of email boxes. EMC IT provides business users with unlimited mailbox sizes, which has resulted in the increased consumption of expensive primary storage. Another challenge EMC IT was facing was controlling large IT support costs related to managing the backup process and its associated infrastructure.

Using EMC SourceOne, EMC IT developed a solution that consolidated the Microsoft Exchange environment into two data centers. EMC SourceOne Email Supervisor extends the capabilities of EMC SourceOne Email Management and email archiving solutions to allow easy monitoring of inbound and outbound email in compliance with corporate policies, NASD regulations, and governance mandates.

This solution also provides a cost-effective way to monitor the organization’s email usage as it moves into the email archiving environment. EMC IT has also used this opportunity to roll out a uniform email archiving policy for the entire organization.

Figure 5 shows the approach and value of an email archiving solution using EMC SourceOne.

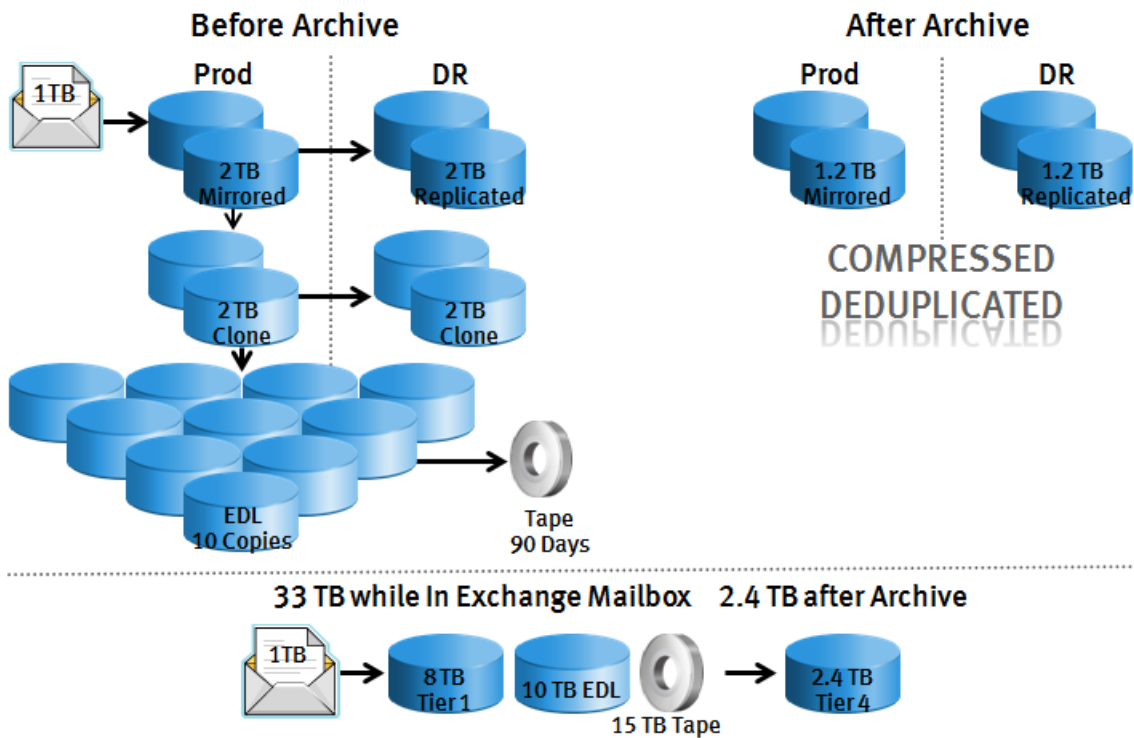


Figure 5. The value of email archiving using EMC SourceOne

Today, data is automatically archived from mailboxes. Using a tiered data approach, a business value is assigned to the information so that storage can be allocated accordingly. As a result, EMC IT has been able to keep the primary storage growth constant and increase the ROI of email archiving.

EMC IT has realized over \$20 million in cost avoidance savings by migrating to this solution. In 2010, the primary storage capacity growth remained nearly static, while only increasing in the archiving tier, thus resulting in a significant savings from the reduction in backup storage needs for primary storage. In addition, as email is now centrally backed up and managed, the cost of legal discovery has been significantly reduced from eight days to eight hours.

Automation

As EMC continues to grow, its dispersed data assets also increase proportionately. Five thousand clients require daily monitoring, with average backup needs of 110 TB. Growth is in excess of 40 PB a year. In addition, there are approximately 3,000 backup and recovery-related incidents that the data center manages every month.

Manual methods had become insufficient, and EMC IT realized that it needed to automate backup and recovery tasks to increase the efficiency of the entire process. This included the ability to discover and resolve backup-related incidents, utilize the data gathered for trending and analysis purposes, and effectively eliminate gaps in protecting sensitive data.

To achieve this, EMC has integrated all of its backup and recovery-related technologies including Data Protection Advisor, NetWorker, Avamar, Data Domain, Disk Library, and Replication Manager, with the Ionix for IT Operations Intelligence tool, and subsequently integrated it with an EMC Incident Tracking system. EMC Ionix for IT Operations Intelligence automates service and infrastructure monitoring, analysis, and reporting. When issues arise, automated, model-based analytics facilitate the ability to restore impacted services and business processes faster than ever before. Not only does this solution increase operational efficiencies, but it also decreases costs on an ongoing basis.

Figure 6 shows a sample integration workflow. The backup infrastructure is first integrated with the Ionix management suite for better automation and management of the infrastructure. From Ionix, further integrations are carried out to incident management, the command center, and finally to escalation systems.

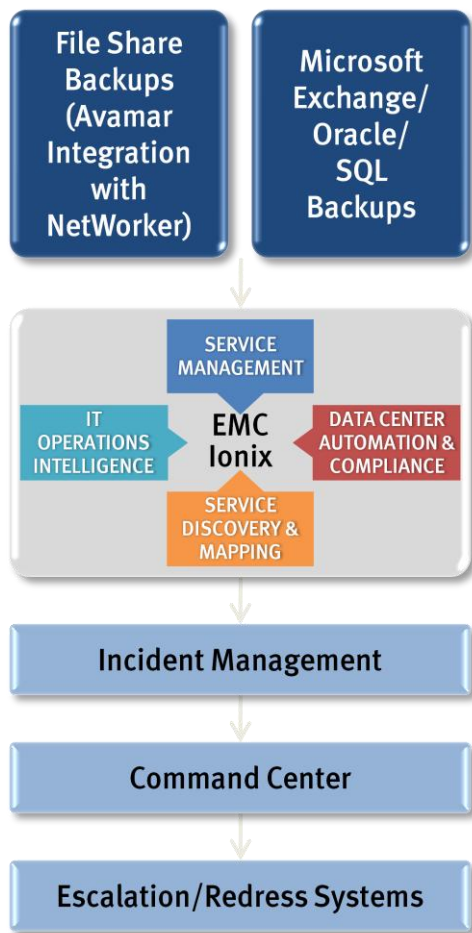


Figure 6. EMC technologies integration in the automation workflow

EMC Ionix for IT Operations Intelligence allows EMC IT to automate realtime incident identification and also perform cross-domain root-cause and impact analysis. This helps EMC IT identify incidents related to backup and recovery and develop methods to overcome the impact of such incidents in the future.

One of the objectives of this automation initiative was to have a single, unified solution that monitors, analyzes, and reports across the backup and recovery lifecycle. EMC Data Protection Advisor helped address this need by automating the collection of data from applications, hosts, and arrays, while it constantly monitored for data protection problems. It also provided realtime alerts on gaps to help avert missed SLAs and data protection objectives. The latest version of EMC’s Data Protection Management solution, Data Protection Advisor for Replication, expands monitoring, analysis, and reporting capabilities to include support for EMC replication software, and provides a single point solution for unified data protection management across backup and recovery.

By using powerful EMC products such as these, EMC IT now has the ability to monitor and troubleshoot all backup-related issues in real time, as well as identify and make proactive changes to the backup and retention policies of Oracle and SQL Server

databases. The changes have reduced storage needs by 40 percent and reduced the amount of tape storage required by 32 percent.

EMC IT has also successfully implemented solutions based on EMC Replication Manager to enable rapid backup and recovery of data from a proxy copy. Replication Manager manages EMC point-in-time replication technologies through a centralized management console, and coordinates the entire data replication process such as monitoring, scheduling, recording, and cataloging replicas. This application-centric product helps EMC IT offload backup processes to a proxy host that can be used for development, staging, and reporting environments.

Use Case: Replication Manager in Microsoft Exchange

EMC's rapid business expansion and acquisition of new companies has resulted in exponential growth of its Microsoft Exchange email volumes and storage. This has impacted backup windows, production performance, and the availability of current backup data.

To address these issues, EMC IT used Replication Manager for monitoring, scheduling, recording, and cataloging its replicas. EMC TimeFinder® local storage replication software is used to create Business Continuous Volumes (BCVs) of Exchange. EMC's Exchange Manager, protected by Replication Manager, now supports 65,000 mailboxes stored on 50 TB of EMC Symmetrix VMAX™, EMC Symmetrix DMX™, and EMC CLARiiON® storage systems.

Through this initiative, the backup window has been reduced from two days to 12 hours per Exchange instance—even as the Exchange infrastructure has grown from 25 TB to 50 TB. It also reduced the impact of Exchange outages from days to just a few hours. In addition, the personnel required to administer backup has been reduced from three Exchange backup administrators to one.

Conclusion

Through its deduplication, archiving, and automation projects, EMC IT has been able to increase the efficiency and performance of its backup and recovery processes and dramatically lower the risk of data loss for EMC business units.

To date, as the amount of data protected has increased by 85 percent, the amount of backup capacity required to store that data has decreased by 49 percent. Accordingly, EMC IT successfully managed to reduce its backup infrastructure costs by 70 percent while increasing the amount of TB supported per backup administrator by 93 percent.

EMC IT has also experienced a significant reduction in the number of backup and recovery trouble tickets and application outages. In addition, the entire operation is more environment-friendly. The need for less equipment has translated into reduced power and cooling demands and a smaller storage footprint.

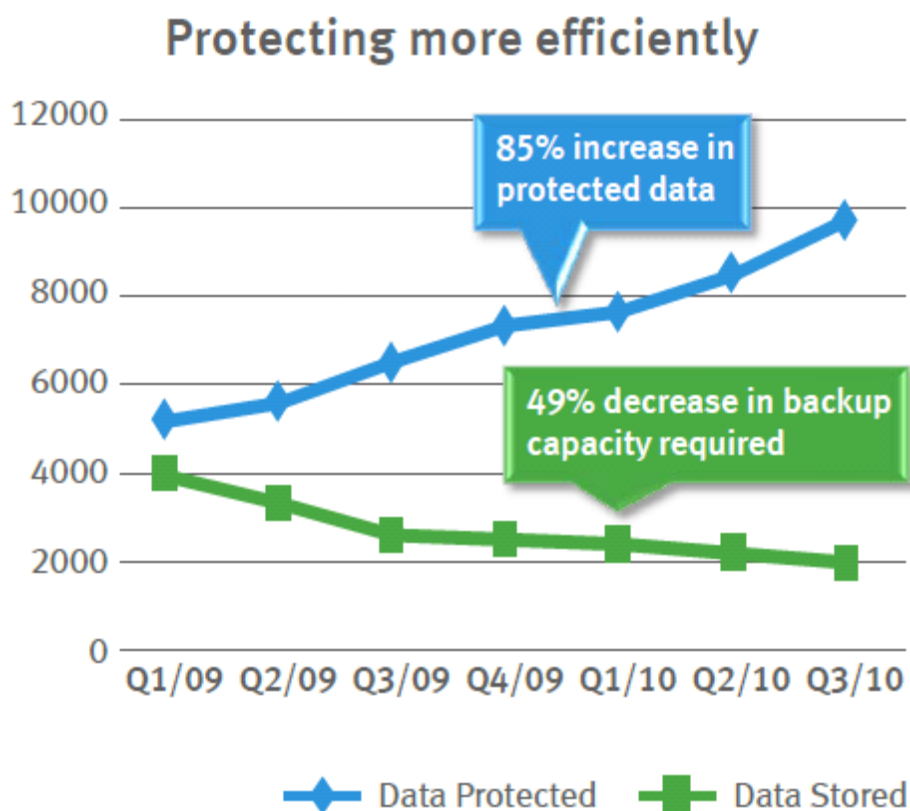


Figure 7. The graph shows the increase in capacity to protect data compared to the reduction in storage capacity

As the company progresses on its journey toward the private cloud, EMC IT will continue efforts to eliminate tape-based backup and recovery systems and further its work in implementing standard policies. Well on its way, EMC IT will soon be fully positioned to provide its business units with a comprehensive Backup and Recovery as a Service offering that is simple to use and administer, green, cost-effective, standardized, and elastic.

References

The following resources provide additional, relevant information. You can access these documents and sites at www.EMC.com or by contacting an EMC representative:

- [EMC IT's Journey to the Private Cloud: A Practitioner's Guide](#)
- EMC IT web page at <http://www.EMC.com/EMCIT>

For more information on EMC products in the backup and recovery domain visit <http://www.EMC.com/products/category/backup-recovery.htm>.