EFFICIENT BACKUP AND LONG-TERM RETENTION FOR MICROSOFT SQL SERVER

EMC Data Domain, EMC NetWorker, EMC CloudBoost, EMC Elastic Cloud Storage

- Optimized backup performance with DD Boost
- Agile and granular recovery
- Long-term retention with EMC CloudBoost

EMC Solutions

Abstract

This white paper describes solutions providing efficient backup, long-term retention, and recovery services for a mixed Microsoft SQL Server environment using EMC NetWorker, EMC Data Domain, EMC CloudBoost, and EMC ECS within the datacenter.

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**Efficient Backup and Long-Term Retention for Microsoft SQL Server**

**EMC Data Domain, EMC NetWorker, EMC CloudBoost, EMC Elastic Cloud Storage**

**White Paper**

Part Number H14834.1
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Executive summary

Business case
Companies are rethinking their next-generation data protection methods as a result of exponential data growth, regulatory compliance requirements, strict service level agreements, and shrinking backup windows. Microsoft SQL Server DBAs and IT teams face additional challenges from the need to better protect data residing throughout the enterprise. Most IT organizations must retain periodic backups for several years. Though long-term retention (LTR) backup copies are infrequently accessed, IT must be able to retrieve them on demand as either full or incremental restores. At the same time, IT is being asked to eliminate the myriad risks associated with tape-based solutions and to control the substantial operating costs imposed by tape LTR. EMC Data Protection Suite™ provides an end-to-end backup and recovery solution to address the needs of any organization interested in protecting its most valuable data and databases. From EMC® NetWorker®, a unified backup and recovery software, through EMC Data Domain®, the market-leading backup appliance the EMC CloudBoost appliance for Long Term Retention (LTR). This data protection solution provides a comprehensive short-term backup for applications, virtual machines, and databases as well as LTR to cloud object storage, which is ideal for long-term data retention with reduced costs. This solution will reduce customers’ CAPEX and OPEX while providing speed of recovery, reliability, flexibility and offsite data storage.

Microsoft SQL Server protection challenges
IT storage administrators or DBAs face the following challenges to protect their SQL Server environments:
- Capacity management for SQL Server database backups
- Very large database (VLDB) protection to ensure both business RTO and RPO
- Granular recovery for SQL Server database to improve operational efficiency
- Longer-term backup retention management for SQL Server database

Solution overview
In this solution, EMC NetWorker with DD Boost™ technology along with Data Domain is used to simulate several highly efficient backup and recovery scenarios of SQL Server databases and logs within the datacenter. We have also deployed Kroll Ontrack PowerControls for rapid and granular recovery of large databases. For longer-term retention, EMC Elastic Cloud Storage (ECS) was used as a LTR backup target, enabled through the CloudBoost appliance.

Key results
The key results of this solution are:
- NetWorker and Data Domain offer quick, simplified, and reliable backup protection for Microsoft SQL Server databases.
- Data Domain can help improve SQL Server database backup performance after the initial full backup with DD Boost technology. In this solution, we prove that DD Boost can:
  - Reduce network bandwidth to Data Domain by over 80 percent after a second full backup
  - Improve the Data Domain average ingest rate by 2.7 times
Introduction

Reduce SQL Server database successive full backup durations by over 60 percent compared to the initial full backup.

EMC NetWorker Module for Microsoft (NMM) offers quick database recovery. In this solution, a 500 GB SQL Server database can be restored within 22 minutes.

Ontrack PowerControls for SQL Server offers on-demand, table-level restoration to achieve database recovery, flexibility, and granularity.

CloudBoost and ECS offer inexpensive and LTR with up to three times the deduplication ratio for SQL Server database within the datacenter.

Document purpose

The white paper validates that this solution can use NetWorker, Data Domain, and EMC XtremIO® to achieve optimum SQL Server backup and recovery performance with a high data-reduction ratio.

The white paper also validates the LTR solution, which uses CloudBoost and ECS to archive SQL Server database within the datacenter for a long time at a low cost.

Scope

This white paper shows:

- Enhanced SQL Server backup performance using NetWorker and DD Boost with extreme bandwidth from XtremIO and minimum written data to Data Domain
- Fast SQL Server database recovery with NMM
- Table-level recovery with Ontrack PowerControls for SQL Server
- Effective and efficient SQL Server backup and recovery to ECS private cloud using CloudBoost

Audience

The primary audience for this white paper includes database and system administrators, storage administrators, cloud administrators, and system architects who are responsible for designing, creating, and maintaining SQL Server environments. Readers should have some familiarity with SQL Server backup and recovery technology, NetWorker, Data Domain, XtremIO, CloudBoost, and ECS.
Introduction

**Terminology and acronyms**

Table 1 provides definitions for some of the terms used in this white paper.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AlwaysOn Availability Group (AlwaysOn AG)</td>
<td>A SQL Server feature that provides high availability and disaster recovery for SQL Server databases. An availability group supports a set of read/write primary databases and up to eight sets of corresponding secondary databases. The secondary databases can be made available for read-only access or some backup operations.</td>
</tr>
<tr>
<td>NetWorker Module for Microsoft (NMM)</td>
<td>A plug-in that is integrated with SQL Server management studio to support backup and recovery technology using Microsoft Volume Shadow Copy Service (VSS) or Microsoft Virtual Device Interface (VDI) technology.</td>
</tr>
<tr>
<td>NetWorker management Console (NMC)</td>
<td>A universal graphic user interface used by EMC NetWorker to deliver the fundamental monitoring, administration, and reporting needs common to any information protection environment.</td>
</tr>
<tr>
<td>SQL Server Management Studio (SSMS)</td>
<td>An integrated environment for accessing, configuring, managing, administering, and developing all components of SQL Server.</td>
</tr>
<tr>
<td>Stripes</td>
<td>In EMC NetWorker, one or more data streams that are extracted in parallel from a database, and written in parallel to multiple media devices.</td>
</tr>
<tr>
<td>Virtual Device Interface (VDI)</td>
<td>NMM uses VDI to communicate with the SQL Server and support backup and restore operations.</td>
</tr>
</tbody>
</table>

**We value your feedback!**

EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact [EMC.Solution.Feedback@emc.com](mailto:EMC.Solution.Feedback@emc.com) with your comments.

**Authors:** Eric Hu, Mark Qin Xu, Reed Tucker
Technology overview

The key technology components used in this solution are:

- EMC NetWorker
- EMC Data Domain
- EMC CloudBoost
- EMC Elastic Cloud Storage
- EMC XtremIO
- Microsoft SQL Server 2012 and 2014
- VMware vSphere 6.0
- Kroll Ontrack PowerControls for Microsoft SQL Server

EMC NetWorker and NetWorker Module for Microsoft

EMC NetWorker is a storage-management software suite that provides backup, recovery, and other services to hosts with a wide variety of operating systems and data types. NetWorker products for different operating systems are interoperable. NetWorker provides the flexibility to design a storage management system that works best with the current computing environment.

NetWorker Module for Microsoft

EMC NetWorker Module for Microsoft (NMM) provides a single, unified solution for protection and recovery of Microsoft Exchange, SQL Server, Microsoft SharePoint, Microsoft Windows Hyper-V, and Microsoft Active Directory. NMM uses VDI, an API provided by SQL Server, to integrate with SQL Server and enable the NetWorker software to back up and recover SQL Server data.

EMC Data Domain and DD Boost

EMC Data Domain systems are disk-based inline deduplication appliances and gateways that provide data protection and disaster recovery in an enterprise environment. Data deduplication is performed on incoming data streams and allows only the new and changed segments of data to be identified and stored as unique instances within Data Domain File System.

EMC DD Boost

EMC DD Boost significantly increases backup performance by distributing parts of the deduplication process to the backup client, so the network bandwidth is saved. Without DD Boost, all data – unique or redundant – is transferred via network to a Data Domain system for deduplication processing. With DD Boost, data is deduplicated first at the backup client; only unique segments are sent to a Data Domain system. DD Boost performs a host-side assisted deduplication job using the following steps:

1. The backup host segments the data to be backed up.
2. The backup host creates fingerprints of segment data and sends them to the Data Domain system.
Technology overview

3. The Data Domain system filters the fingerprints sent by the backup host and requests data not previously stored.

4. The backup host sends only the requested unique data segments to the Data Domain system.

5. The Data Domain system notes references to previously stored data and writes new data to disks.

EMC CloudBoost

EMC CloudBoost is a cloud-enabling technology for EMC Data Protection Suite™ and third-party software. CloudBoost enables the extension of the datacenter to the private or public cloud for LTR, and is a low-cost alternative to tape or local-disk backup.

CloudBoost is available as both physical and virtual appliances. CloudBoost delivers enterprise-grade security even when data is stored or transferred outside a firewall. Data is always segmented and encrypted, and all data transfers occur using Microsoft Transport Layer Security protocol (TLS).

EMC Elastic Cloud Storage

EMC Elastic Cloud Storage (ECS) is a complete, software-defined cloud-storage platform that supports the storage, manipulation, and analysis of unstructured data on a massive scale on commodity hardware. ECS is specifically designed to support mobile, cloud, Big Data, and social networking applications. ECS can be deployed as a turn-key storage appliance or as a software product that can be installed on a set of qualified commodity servers and disks.

EMC XtremIO

EMC XtremIO is an all-flash storage array that has been designed to deliver array-based capabilities that use the unique characteristics of solid-state drives (SSDs) based on flash media. XtremIO uses industry-standard components and proprietary intelligent software to deliver unparalleled levels of performance. Achievable performance ranges from hundreds of thousands to millions of IOPS, and consistent low latency of under one millisecond.

Kroll Ontrack PowerControls for Microsoft SQL Server

Kroll Ontrack PowerControls for Microsoft SQL Server offers a finer recovery granularity to restore SQL Server tables without restoring the entire database. Ontrack PowerControls can preview table content before restoration, and complete the table restore by dragging and dropping the copied tables directly to the environment, which saves hours or days compared to whole database recovery. Ontrack PowerControls also supports restoration from snapshots and native compressed/uncompressed SQL Server backups.
Solution architecture overview

To help customers protect business applications and data, this solution provides data protection for SQL Server using EMC products. To protect a mixed environment of SQL Server 2012 and SQL Server 2014 with normal, encrypted, and compressed databases, the solution provides efficient backup to Data Domain through the use of the following technologies:

- Data Domain and DD Boost
- NetWorker and NMM
- XtremIO
- Ontrack PowerControls

Using the following technologies, this solution provides a clone of the backup for LTR to ECS:

- CloudBoost
- ECS
- NetWorker and NMM

In this solution, we built the entire infrastructure on VMware vSphere ESXi 6.0. All virtual machines and SQL Server databases are stored on XtremIO via a Fibre Channel (FC) network. All components are connected to a manageable 10 Gb for Ethernet (GbE) network. Figure 1 shows the physical architecture of the solution.

Architecture diagram

10 Gigabit Ethernet

VMware ESXi 6.0 HA Cluster

ESXi 6.0 Hosts

XtremIO

Storage Fibre Channel Network

DD4200

ECS

Figure 1. Solution architecture diagram
This solution’s architecture is made up of several components:

- **Storage:** All virtual machines and SQL Server databases are stored on a single-EMC XtremIO X-Brick® with 15 TB of usable physical capacity. XtremIO is connected to the SAN network with four 8 Gb FC cables.

- **Backup:**
  - Data Domain is the backup target for efficient daily backup with thirty 3 TB NL-SAS disks. It is connected to a 10 GbE LAN with a virtual interface consisting of two 10 GbE network interface cards (NICs) configured in round-robin mode.
  - ECS is the backup target for LTR in the datacenter, consisting of one node and one DAE with fifteen 6 TB NL-SAS disks. ECS is connected to a 10 GbE LAN with one 10 GbE NIC on its node.
  - NetWorker is the storage management software that provides backup, recovery and clone services.
  - CloudBoost virtual appliance enables cloning the data from Data Domain to ECS.

- **SQL Server:**
  - Standalone SQL Server 2012 has six databases with different types of normal, compressed, and encrypted data. Its raw capacity is 4.25 TB.
  - The two SQL Server 2014 instances with AlwaysOn Availability Group configuration have three databases on each node. Their raw capacity is 3.5 TB.

- **Network:** Composed of two 10 GbE IP switches and two director-class SAN switches

- **Physical servers and virtualization:**
  - Composed of three servers that use a total of 20 cores, 2.4GHz, and 160 GB RAM. Each server is connected to the SAN network with two 8 Gb FC cables and to the LAN with two 10 GbE cables.
  - The servers are installed with VMware vSphere 6.0 and configured as a vSphere ESXi cluster with high availability enabled. All virtual machines and appliances are hosted in this cluster.

### Hardware and software resources

Table 2 details the hardware resources used in this solution.

**Table 2. Hardware resources**

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term backup target appliance</td>
<td>1</td>
<td>EMC Data Domain DD4200 consisting of 30 x 3 TB NL-SAS disks</td>
</tr>
<tr>
<td>Long-term backup target appliance</td>
<td>1</td>
<td>EMC Elastic Cloud Storage U300, 1 node, and 1 DAE with 15 x 6 TB NL-SAS disks</td>
</tr>
<tr>
<td>Storage array</td>
<td>1</td>
<td>EMC XtremIO consisting of 1 X-Brick, 25 x 800 GB SSDs</td>
</tr>
</tbody>
</table>
Solution architecture overview

Effective Backup and Long-Term Retention for Microsoft SQL Server

EMC Data Domain, EMC NetWorker, EMC CloudBoost, EMC Elastic Cloud Storage

White Paper

Table 3 lists the software resources used in this solution.

### Table 3. Software resources

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC NetWorker</td>
<td>8.2.2.1</td>
<td>Backup and recovery software</td>
</tr>
<tr>
<td>EMC NetWorker Module for Microsoft</td>
<td>8.2.2.1</td>
<td>Provides backup and recovery support for Microsoft applications in NetWorker</td>
</tr>
<tr>
<td>EMC Data Domain Operating System</td>
<td>5.7</td>
<td>Operating environment for Data Domain</td>
</tr>
<tr>
<td>EMC XtremIO</td>
<td>4.0.1</td>
<td>All-flash storage</td>
</tr>
<tr>
<td>EMC CloudBoost</td>
<td>2.0</td>
<td>Provides long-term retention of backups to public or private cloud storage</td>
</tr>
<tr>
<td>EMC Elastic Cloud Storage</td>
<td>2.2</td>
<td>Cloud storage platform</td>
</tr>
<tr>
<td>VMware vSphere</td>
<td>6.0</td>
<td>Hypervisor hosting all virtual machines</td>
</tr>
<tr>
<td>VMware vCenter</td>
<td>6.0</td>
<td>Management of vSphere</td>
</tr>
<tr>
<td>Microsoft Windows 2012 R2 Datacenter</td>
<td></td>
<td>Operating system for database servers</td>
</tr>
<tr>
<td>Microsoft SQL Server 2014 Enterprise Edition</td>
<td></td>
<td>Database software</td>
</tr>
<tr>
<td>Microsoft SQL Server 2012</td>
<td>SQL 2012 SP2 Enterprise Edition</td>
<td>Database software</td>
</tr>
<tr>
<td>Microsoft BenchCraft Toolkit</td>
<td>1.12.0-1026</td>
<td>Database workload tool to generate data change</td>
</tr>
</tbody>
</table>
Solution design and best practices

Overview
This chapter describes best practices and considerations for designing this solution, and covers the following components:

- SQL Server environment, including SQL Server application and XtremIO as back-end storage
- Backup plans designed for this solution
- Backup components, including NetWorker, Data Domain, ECS, and CloudBoost
- Network including IP and SAN
- Virtualization

SQL Server design and considerations
The solution is designed for short-term backup, LTR, and resiliency. This white paper describes both backup and recovery use cases for SQL Server database environments, with multiple databases across both SQL Server 2012 and SQL Server 2014 platforms.

We designed a SQL Server 2012 standalone instance to host databases with different sizes and configurations. EMC recommends implementing multiple files for each database, and spreading those files evenly across multiple LUNs to increase backup read parallelism.

Table 4 details the database configuration for SQL Server 2012.

<table>
<thead>
<tr>
<th>Database Name</th>
<th>Size</th>
<th>Number of file groups</th>
<th>Number of files per file group</th>
<th>Number of LUNs</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB1</td>
<td>250 GB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Small database</td>
</tr>
<tr>
<td>DB2</td>
<td>250 GB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>DB1 with AES256 algorithm encrypted</td>
</tr>
<tr>
<td>DB3</td>
<td>150 GB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>DB1 with page compressed</td>
</tr>
<tr>
<td>DB4</td>
<td>500 GB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Medium database</td>
</tr>
<tr>
<td>DB5</td>
<td>1 TB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Large database</td>
</tr>
<tr>
<td>DB6</td>
<td>2 TB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Very Large database</td>
</tr>
</tbody>
</table>

We also designed a SQL Server 2014 database with AlwaysOn AG enabled on two instances to validate a backup and recovery use case for clustered databases. Table 5 details the database configuration for SQL Server 2014.
Table 5. Database configuration for SQL Server 2014

<table>
<thead>
<tr>
<th>Database Name</th>
<th>Size</th>
<th>Number of file groups</th>
<th>Number of files per file group</th>
<th>Number of LUNs</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB7</td>
<td>500 GB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>AlwaysOn AG databases across two nodes</td>
</tr>
<tr>
<td>DB8</td>
<td>1 TB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>DB9</td>
<td>2 TB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

To initiate an offloaded backup job for SQL Server 2014 with AlwaysOn AG configuration from the secondary node, we ensured that the **Backup Preferences** of the database availability group were set to **Prefer Secondary**, as shown in Figure 2.

![Figure 2. Backup preferences for AlwaysOn AG databases](image)

**XtremIO storage design and considerations**

In this solution, we deployed all the databases in an XtremIO single X-Brick all-flash array with four 8 Gb FC connections to each vSphere ESXi host.

XtremIO ensures high performance and ultra-low latency in the SQL Server production environment. With XtremIO data protection, together with storage deduplication and compression features, XtremIO offers high availability and low cost per usable GB for SQL Server databases. XtremIO thin provisioning also prevents large volume allocations of databases from wasting physical storage before it is needed, while still providing room for future growth as required.

The XtremIO 4.0 Integrated Copy Data Management (iCDM) feature enables powerful, risk-free copy operations for SQL Server databases. iCDM consolidates both primary and associated copies on the same all-flash array for unprecedented agility and efficiency. iCDM hosts both production and non-production database environments with linear performance scalability.
Figure 3 shows the XtremIO single X-Brick configuration used in this solution. The array is configured with twenty-five 400 GB SSDs, with 15.25 TB total usable capacity.

Table 6: XtremIO storage design for SQL Server 2012 and SQL Server 2014

<table>
<thead>
<tr>
<th>Volume name</th>
<th>Description</th>
<th>Volume quantity</th>
<th>Volume capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL2012_Data</td>
<td>Volume for database datafiles</td>
<td>4 per database</td>
<td>2.5 TB</td>
</tr>
<tr>
<td>SQL2012_Temp_Log</td>
<td>Volume for database logs and tempdb of SQL Server 2012</td>
<td>1</td>
<td>2 TB</td>
</tr>
<tr>
<td>SQL2014_Primary_Data</td>
<td>Volume for database datafiles</td>
<td>4 per database</td>
<td>2.5 TB</td>
</tr>
<tr>
<td>SQL2014_Primary_Temp_Log</td>
<td>Volume for database logs and tempdb of SQL Server 2014 primary instance</td>
<td>1</td>
<td>2 TB</td>
</tr>
</tbody>
</table>
Backup plan and considerations for SQL Server

### SQL Server database recovery model

The recovery model of a SQL Server database determines what types of backups and which restore scenarios are supported for the database. It controls how the database transaction logs are managed. SQL Server offers three types of recovery model:

- **Simple recovery model**: No transaction log backup management is required. Users could lose data as the database can only be restored to the end of the most recent backup.

- **Full recovery model**: Frequent transaction log backup is required to guarantee minimum data loss in the broadest range of failure scenarios.

- **Bulk-logged recovery model**: Use this recovery model intermittently to improve performance before large-scale bulk operations.

EMC recommends using the full recovery model to protect your production database and to ensure the best RPO. Schedule the transaction log backup plan to support point-in-time recovery to reduce potential data loss. Provide enough storage space for transaction logs when using the full recovery model.

### Backup plan considerations

It is important to design backup plans for the databases to ensure both RPO and RTO of the SQL Server environment. Consider the following backup plans: Full backup, differential backup, log backup, and backup clone provided by NetWorker to achieve SQL Server database LTR.

NetWorker with DD Boost offers enormous data deduplication capabilities for SQL Server databases. It enables users to design a simple backup plan for SQL Server and accelerate the recovery process.

Table 7 shows the daily and weekly backup plans for SQL Server databases designed in this solution. Instead of differential backups, we ran full backups every day. If a user wants to restore the database to a certain time on Friday, the user only needs to restore the full backup from Thursday and a series of transactional backups from Friday, with no requirement to restore all the backups of previous days.

At the end of the week, for SQL Server database LTR, we cloned the weekly backup to ECS storage.

<table>
<thead>
<tr>
<th>Volume name</th>
<th>Description</th>
<th>Volume quantity</th>
<th>Volume capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL2014_Secondary_Data</td>
<td>Volume for database datafiles</td>
<td>4 per database</td>
<td>2.5 TB</td>
</tr>
<tr>
<td>SQL2014_Secondary_Temp_Log</td>
<td>Volume for database logs and tempdb of SQL Server 2014 secondary instance</td>
<td>1</td>
<td>2 TB</td>
</tr>
<tr>
<td>VMOS</td>
<td>Volume for virtual machine operating systems</td>
<td>1</td>
<td>2 TB</td>
</tr>
</tbody>
</table>
### Table 7. Backup plans used in this solution

<table>
<thead>
<tr>
<th>Time</th>
<th>Backup type</th>
<th>Backup target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Daily full backup</td>
<td>Data Domain</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Daily full backup</td>
<td>Data Domain</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Daily full backup</td>
<td>Data Domain</td>
</tr>
<tr>
<td>Thursday</td>
<td>Daily full backup</td>
<td>Data Domain</td>
</tr>
<tr>
<td>Friday</td>
<td>Daily full backup</td>
<td>Data Domain</td>
</tr>
<tr>
<td>Weekend</td>
<td>Daily full backup, also as weekly backup</td>
<td>Backup to Data Domain, and then cloned to ECS by CloudBoost for LTR</td>
</tr>
</tbody>
</table>

**Backup data flows in this solution**

As shown in Figure 4, the daily full backup sends data to Data Domain from both the SQL Server 2012 stand-alone instance and the secondary node of SQL Server 2014 with AlwaysOn AG. When a certain database must be recovered to its recent version from Data Domain, data is restored to the target SQL Server. SQL Server exchanges management information with the NetWorker server when performing backup and recovery.

![Backup data flows in this solution](image)

**Figure 4. Short-term data protection data flow**

As shown in Figure 5, for LTR within the datacenter, back up the SQL Server databases to Data Domain each weekday, and then again on the weekend as a weekly backup. On NetWorker, clone the weekend copy to the configured CloudBoost storage node to store the database on ECS.

When a specific database must be recovered to its version from weeks or months ago, data is restored to the target SQL Server from ECS via CloudBoost. SQL Server exchanges management information with the NetWorker server while performing backup and recovery.
This section describes the design and considerations for deploying NetWorker in this solution.

**Client, storage node, and NMM**

In this solution, we installed a NetWorker storage node to each backup client (each SQL server). We did not need to transfer backup data from the backup client to the backup storage node over the LAN, which enhances backup performance.

We also installed NMM on each backup client to leverage NMM’s use of VDI to support SQL Server backup and recovery for NetWorker. After installing NMM on SQL Server client, a NetWorker plug-in appears in SSMS. NetWorker User for SQL Server is also installed in SQL Server. Both interfaces help to back up or recover SQL Server databases.

**Striped backup and recovery**

NMM supports the use of up to 32 stripes for backing up and restoring SQL Server data. Stripes are data streams that are extracted in parallel from a database, and written in parallel to multiple media devices. With NMM, striping can yield a significant performance advantage when a large amount of data is backed up and recovered using multiple drives.

As shown in Figure 6, when performing a short-term backup using DD Boost, we configured 32 stripes. DD Boost deduplicates the data at the host side, so far less data is actually transferred through Ethernet. Adding more stripes increases the read bandwidth from XtremIO and enhances the backup performance.
Solution design and best practices

*Efficient Backup and Long-Term Retention for Microsoft SQL Server*

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**White Paper**

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Figure 6. Striped backup configuration in NMM

**Federated backup**

By using the AlwaysOn AG feature of SQL Server 2012 or later, users can keep their databases under an AG for high availability. Also, the database administrator can set the backup priority for the AG or a database in the AG and nominate a particular replica for the backup. This improves backup performance. NMM supports federated backups, during which NMM detects the SQL Server preferred backup setting for the AG and performs the backup at the preferred node.

We configured databases in the SQL 2014 instance with AlwaysOn AG. To back up these databases, we used federated backup and created a client resource for the windows cluster name.

Figure 7 shows the properties of a federated backup client.

**NetWorker device configuration and striping**

A device is a storage unit or folder that can contain a backup volume. A device can be a tape, optical drive, autochanger, or disk connected to the server or storage node.

If striping is used to perform the SQL Server database backup with few stripes, configure the number of devices to be equal to the number of stripes. Specify one target session for each device to yield the best backup performance on the client host by eliminating interleaving.

If striped backup is used with a large number of stripes, configuring the same number of devices as the number of stripes would create a large administration workload in
NMC. Make sure the number of devices multiplied by the number of target sessions specified for each device equals the stripe amount.

For example, in this solution, we configured the stripe amount as 32 to achieve the best backup performance. On the NetWorker Management Console (NMC), we created eight devices and set target sessions of each device to four so that the 32 backup sessions could be evenly distributed to the eight devices.

For more information, refer to the NetWorker 8.2 SP1 Installation Guide, NetWorker, NetWorker Module for Microsoft Release 8.2 SP1 Installation Guide, NetWorker 8.2 SP1 Administration Guide, NetWorker Module for Microsoft for SQL VDI Release 8.2 SP1 User Guide.

**NetWorker design best practices**

EMC recommends that you follow these best practices to optimize backup performance when setting up SQL Server databases:

- Implement NetWorker stripe backup to allow backup to multiple NetWorker devices to increase write parallelism.

- Configure more NICs for the backup client to ensure enough network bandwidth for a backup data transfer.

- If the NetWorker version is prior to 8.2.2, for VLDB, set NetWorker parameters NSR_VDI_MAXTRANSFERSIZE and NSR_Read_BufferSize to 4 MB to improve the backup performance and DD Boost deduplication ratio. For more information, contact your EMC representative.

This section describes the design and considerations for Data Domain in this solution.

**Data Domain design and considerations**

**Data Domain with NetWorker**

In this solution, Data Domain is integrated with NetWorker so that a NetWorker device can be created on Data Domain and attached to a NetWorker storage node. As shown in Figure 8:

- For DD Boost backup, create a Data Domain device directly.
- For non-DD Boost backup, create a CIFS share on Data Domain, and then create an Advanced File Type Device.
Data Domain disk configuration

In this solution, there are thirty 3 TB NL-SAS disks in two disk enclosures in Data Domain. All disks are configured in the active tier, with two of them used as spare disks. Therefore, 28 disks serve read/write I/O operations for either backup or recovery, as shown in Figure 9.

EMC recommends these additional configuration considerations:

- Create a virtual interface consisting of two 10 GbE physical interfaces. Configure the bonding type as aggregate and mode as round-robin. This could increase network throughput.
- Set the clean schedule to “never” to prevent it starting during backup or recovery.
For more information, refer to the *Data Domain Operating System Administration Guide, 5.7.*

**ECS design and considerations**

ECS is an ideal choice for users seeking a highly scalable, robust, and affordable private-cloud solution. An ECS appliance is deployed for this solution. CloudBoost, integrated with ECS, provides the secure, high-performance path from the backup solution to this enterprise-grade object store. If data-at-rest encryption is required by compliance or other regulations, consider enabling ECS through CloudBoost processes. Do not double-encrypt data through CloudBoost and ECS processes.

**Initial tasks on ECS**

To set up an ECS user and bucket with restricted access:

1. Create an ECS user and configure the access key for this user so that CloudBoost can use this credential to integrate with ECS.
2. To isolate the storage used for LTR, create an ECS bucket and only grant access to the user you use to integrate with CloudBoost.

**ECS disk configuration**

In this solution, ECS is equipped with a disk-array enclosure of fifteen 4 TB NL-SAS disks configured in a storage pool. As CloudBoost expects to achieve two to four times the ratio of deduplication, ECS can store up to 240 TB of logical SQL Server database data with this configuration. For more information, refer to the *ECS 2.2 Planning Guide.*

**CloudBoost design and considerations**

CloudBoost supports a wide range of private and public object stores including ECS, and delivers a consistent data-security strategy. CloudBoost is available in both physical and virtual forms, with a range of Site Cache capacities to fit any budget and set of requirements:

- CloudBoost physical edition is available in two models depending on the amount of local cache included: CloudBoost 100-10 (10 TB local cache) and CloudBoost 100-30 (32 TB local cache).
- CloudBoost virtual edition is available in two models depending on the amount of cache included: CloudBoost 100-2 (2 TB) and 100-6 (6 TB).

**CloudBoost deployment in this solution**

We deployed CloudBoost as a virtual appliance from the Open Virtual Machine Format (OVMF) template in vCenter. Because CloudBoost and ECS are both deployed in the reliable LAN network, Site Cache is turned off to avoid additional overhead.

CloudBoost requires 750 GB SSDs, 16 cores, and 64 GB of RAM. At least 100 GB is required to store CloudBoost metadata, which allows the appliance to address 400 TB of logical capacity. By default, the metadata is set to 10 GB, but can be modified in the *Virtual Machine Properties* settings, as shown in Figure 10.
After deployment, perform a preliminary configuration in CLI to provide IP, hostname, DNS, and so on. Register the CloudBoost appliance in the EMC Cloud Portal, as shown in Figure 11.

CloudBoost with ECS

Individual CloudBoost deployments can support only one target object store. When a cloud object is selected and CloudBoost is configured, the appliance is locked to that target.

To configure the cloud object, validate its credentials in CLI. The following command shows the validation of ECS object storage:

```
diagnostics blobstore-cli "--provider s3 --endpoint http://<IP>:9020 --identity <user_name> --credential <credential>" validate
```

In EMC Cloud Portal, create a cloud profile containing ECS information and credentials and apply it to the CloudBoost appliance to complete the integration between CloudBoost and ECS, as shown in Figure 12.
This section describes how CloudBoost works with NetWorker and how to integrate them. NetWorker sends a backup clone to the CloudBoost appliance. CloudBoost translates these clones into generic objects that are sent to ECS. CloudBoost presents itself as a NetWorker advanced File Type Device. The enabled workflow is a clone operation to the cloud; it is not a backup to the cloud.

To use CloudBoost as a clone destination, add it as a storage node, and then create a subdirectory under `/mnt/magfs/base`, as shown in Figure 13.
Network design and considerations

This section describes the network details used in this solution for SAN and IP network configuration.

IP network

EMC recommends that you use the following IP network best practices:

- Use multiple network cards and switches for network redundancy.
- Use 10 GbE NICs for data backup and recovery.
- Enable and configure jumbo frames throughout the physical or virtual stack for a 10 GbE network.

SAN networking

EMC recommends that you use the following SAN network best practices:

- Use 8 Gb/s FC switches and HBA ports.
- Use multiple HBAs on the ESXi servers and at least two SAN switches to provide multiple redundant paths between the server and the XtremIO storage array.
- On SAN switches, connect cables to ports of different port groups to ensure all paths can achieve the maximum 8 Gb/s bandwidth.

Virtualization design and considerations

This solution implements the following virtualization design considerations:

- Install three physical hosts as ESXi 6.0 servers. Configure these ESXi servers as a cluster and enable them for high availability. Build all virtual machines on this high-availability cluster.
- Connect SQL Server 2012 virtual machines and SQL Server 2014 passive-node virtual machines to different physical NICs to achieve maximum bandwidth when performing backups.

For more information, refer to the NetWorker with CloudBoost 2.0 Integration Guide.
- Create a virtual machine and install Windows Server 2012 R2, and then install NetWorker server software.

- Deploy the CloudBoost virtual appliance using the OVMF template. Ensure 750 GB SSDs, 16 cores, and 64 GB of RAM are available. Table 8 shows the detailed configuration for virtual machines deployed for this solution.

<table>
<thead>
<tr>
<th>Virtual machine role</th>
<th>Qty</th>
<th>vCPU</th>
<th>Memory (GB)</th>
<th>Application data - VMDK configuration</th>
<th>VMware Datastore</th>
<th>XtremIO volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL Server 2012 stand-alone instance</td>
<td>1</td>
<td>16</td>
<td>128</td>
<td>2.5 TB * 4 Database file</td>
<td>SQL2012_Data_DS</td>
<td>SQL2012_Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 TB Database log file</td>
<td>SQL2012_TempLog_DS</td>
<td>SQL2012_Temp_Log</td>
</tr>
<tr>
<td>SQL Server 2014 configured with AlwaysOn Availability Group</td>
<td>2</td>
<td>16</td>
<td>128</td>
<td>2.5TB * 4 Database file</td>
<td>SQL2014_PriData_DS, SQL2014_SecData_DS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 TB Database log file</td>
<td>SQL2014_PriTempLog_DS, SQL2014_SecTempLog_DS</td>
<td></td>
</tr>
<tr>
<td>NetWorker Server</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>Not applicable</td>
<td>VMOS_DS</td>
<td>VMOS</td>
</tr>
<tr>
<td>CloudBoost virtual appliance</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>Not applicable</td>
<td>VMOS_DS</td>
<td>VMOS</td>
</tr>
</tbody>
</table>
Solution validation and testing

Overview
This section describes the different test use cases that we verified for backup and recovery of SQL Server, including:

- Daily backup and recovery test using NetWorker and Data Domain:
  - First without DD Boost enabled (Non-DD Boost test results)
  - Then with DD Boost enabled to verify the performance improvement (DD Boost test results)
  - Rapid, granular recovery from Data Domain
- Long-term backup retention test using NetWorker with CloudBoost and ECS
  - Clone weekly backup on Data Domain to ECS via CloudBoost
  - Long-term repository recovery from ECS

Test use case overview
This test use case has two parts:
- **Non-DD Boost Test**: Demonstrates SQL Server daily backup using NetWorker to backup diversified databases from XtremIO array to Data Domain without DD Boost enabled.
- **DD Boost Test**: Demonstrates how DD Boost helps accelerate SQL Server backup performance using NetWorker to back up diversified databases from the XtremIO array to Data Domain.

Test objectives
This use case describes backup acceleration for SQL Server databases to Data Domain with and without DD Boost enabled. We validated:

- Backup of SQL Server databases from XtremIO to CIFS share (without DD Boost) on Data Domain using NetWorker
- DD Boost savings of SQL Server databases backup from XtremIO to Data Domain using EMC NetWorker
- Data deduplication savings of Data Domain after each full backup job

Test method
These steps describe how the test was conducted:

1. Cleaned up Data Domain to ensure that there was no existing data on it.
2. Configured NetWorker clients, created NetWorker devices, and configured the NetWorker parameters as listed in Table 9.
Table 9. **NetWorker parameter settings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NetWorker stripe count</td>
<td>32</td>
</tr>
<tr>
<td>NetWorker device count</td>
<td>8</td>
</tr>
<tr>
<td>Target session per NetWorker device</td>
<td>4</td>
</tr>
</tbody>
</table>

3. Started the initial full backup:
   a. For SQL Server 2012, started the instance backup using NetWorker Module for Microsoft SQL Server for all the databases.
   b. For SQL Server 2014, started the backup job from the NetWorker Management Console for the database configured with AlwaysOn AG.

4. Measured and captured metrics for initial full backup.

5. Generated 5 percent data change to simulate daily operation for each production databases using SQL Server workload generator tool.

6. For the non-DD Boost test, performed another round of testing (two rounds in total). For details, refer to steps 3 to 5.

7. For the DD Boost test, performed another five rounds of testing (six rounds in total) to simulate daily backup operations for a whole week. For details, refer to steps 3 to 5.

**Test results**

The test metrics of this use case are listed in Table 10.

Table 10. **Test metrics, use case 2**

<table>
<thead>
<tr>
<th>Data source</th>
<th>Metrics</th>
<th>Collect method</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtremIO</td>
<td>Bandwidth MB/s – Reading Data</td>
<td>XMS</td>
</tr>
<tr>
<td>Data Domain</td>
<td>Deduplication Ratio</td>
<td># fileys show compression /data/col1/NoDDBoost # ddboost show stats</td>
</tr>
<tr>
<td></td>
<td>DD Disk Utilization Percentage</td>
<td># disk show performance</td>
</tr>
<tr>
<td></td>
<td>DD CPU and Memory Utilization</td>
<td># system show performance</td>
</tr>
<tr>
<td></td>
<td>Percentage</td>
<td># system show meminfo</td>
</tr>
<tr>
<td>Windows Performance Monitor</td>
<td>Network Bandwidth MB/s – Writing Data</td>
<td>Network Interface – Bytes Total/sec</td>
</tr>
<tr>
<td></td>
<td>Host Processor Time Percentage</td>
<td>Processor Information - % Processor Time</td>
</tr>
<tr>
<td>NetWorker</td>
<td>Backup duration</td>
<td>NetWorker Management Console</td>
</tr>
<tr>
<td>SQL Server</td>
<td>Total Backup Data GB</td>
<td>sp_spaceused</td>
</tr>
</tbody>
</table>
Non-DD Boost test results

Table 11 lists the key test results in this test. Comparing the two backup rounds, the test results are close to each other except that the data deduplication rate is improved. If DD Boost is disabled, data deduplication is performed on the Data Domain side instead of on the host side of each SQL Server instance. All the data must still be transferred through the network to Data Domain. As a result, the backup duration improved only slightly despite significant savings in deduplication.

<table>
<thead>
<tr>
<th>Backup round</th>
<th>Total dataset (GB)</th>
<th>Actual backup size (GB)</th>
<th>Backup duration (Minute)</th>
<th>Data Domain ingest rate (TB/hr)</th>
<th>Data deduplication rate</th>
<th>XtremIO bandwidth (MB/s)</th>
<th>Network bandwidth (MB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial backup</td>
<td>8,664</td>
<td>6,422</td>
<td>152</td>
<td>2.47</td>
<td>1.06</td>
<td>739</td>
<td>743</td>
</tr>
<tr>
<td>Second backup</td>
<td>8,664</td>
<td>6,423</td>
<td>132</td>
<td>2.85</td>
<td>12.14</td>
<td>839</td>
<td>842</td>
</tr>
</tbody>
</table>

For more test results and details regarding this test, refer to the Test results comparison with and without DD Boost section.

DD Boost test results

Table 12 shows the database size and total backup data for each test round. We implement a five percent data change to simulate the workload of each day.

<table>
<thead>
<tr>
<th>Backup round</th>
<th>Total dataset (GB)</th>
<th>Actual backup size (GB)</th>
<th>Data change ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday - Initial</td>
<td>8,664</td>
<td>6,424</td>
<td>Five percent, including update, insert, and delete operations</td>
</tr>
<tr>
<td>Tuesday - Second</td>
<td>8,664</td>
<td>6,425</td>
<td></td>
</tr>
<tr>
<td>Wednesday - Third</td>
<td>8,664</td>
<td>6,425</td>
<td></td>
</tr>
<tr>
<td>Thursday - Fourth</td>
<td>8,664</td>
<td>6,426</td>
<td></td>
</tr>
<tr>
<td>Friday - Fifth</td>
<td>8,664</td>
<td>6,426</td>
<td></td>
</tr>
<tr>
<td>Weekend - Weekly</td>
<td>8,664</td>
<td>6,427</td>
<td></td>
</tr>
</tbody>
</table>

Figure 14 shows the test results for the backup bandwidth.
During the initial full backup, the average read bandwidth achieved from XtremIO is 957 MB/s. The average write bandwidth sustained over the network to Data Domain is 988 MB/s, which is not reduced despite enabling DD Boost. This is because that the page headers of the original database set are unique, so most data could not be deduplicated.

Results from full backups that simulate a whole week’s operation show that:

- XtremIO average read bandwidth increased to around 2,800 MB/s.
- Network average write bandwidth to Data Domain was reduced to only 200 MB/s.

By performing parts of the deduplication job on the SQL Server host side, DD Boost helps to minimize the network bandwidth to about 80 percent and accelerate the database backup performance by 2.8 times.

Figure 15 shows the deduplication ratio achieved in the test. In the initial full backup, there is little savings from DD Boost due to the uniqueness of the dataset. After the second full backup, the deduplication ratio increased from 1.03 to 15.94, even with a five percent data change. In the full backups, the deduplication ratio maintained the same level. The cumulative deduplication ratio was kept constant, and the data reduction gain from DD Boost was consistent.

**Note:** Your results may vary depending on how many duplicates there are in the data of your specific environment.
Figure 15. Deduplication results

Figure 16 shows the total backup duration savings from DD Boost for SQL Server databases. With a total actual data size up to 6.4 TB for both SQL Server 2012 and SQL Server 2014, the backup duration decreased from 118 minutes for the initial full backup to about 44 minutes for the subsequent full backups. This is a savings of about 63 percent.

Figure 16. Backup duration results for each test round with DD Boost

Figure 17 shows that the average ingestion ratio of Data Domain increased from 3.19 TB/hr in the initial backup to over 8.50 TB/hr in successive backups, boosting performance by 2.7 times.
Solution validation and testing

Figure 17. Data Domain average ingest rate results

Figure 18 shows that the peak ingestion rate of Data Domain reaches over 10.8 TB/hr when the backups for SQL Server 2012 and SQL Server 2014 are running simultaneously. When the SQL Server 2014 backup job finished first, the peak ingestion rate was reduced to about 5.5 TB/hr.

Note: The databases on SQL Server 2012 instance are backed up one by one with NMM, so you can see the intermittent ingestion rate in Figure 17.

Table 13 shows the processor utilization status on SQL Server and Data Domain, and the disk utilization status on Data Domain during the DD Boost test.
DD Boost performs parts of the data deduplication job on the SQL Server client side. Therefore, as listed in Table 13:

- The processor time utilization of each SQL Server instance increased as the deduplication job changed from target to source.
- The CPU utilization of Data Domain dropped as less data was transferred to it.

The disk performance of the Data Domain system can be summarized as follows:

- During the initial full backup, due to limited data reduction ratio on the SQL Server side:
  - 988 MB/s data was written to disk as shown in Figure 14 on page 29.
  - We achieved on average 91 percent disk utilization and 43 ms disk response time on the Data Domain system, as listed in Table 13.
  - The results indicate that Data Domain was already under disk pressure for the initial full backup.
- After the initial full backup, as the deduplication ratio increased, the amount of data transferred to Data Domain was reduced greatly. This alleviated the disk pressure of the Data Domain system.
  - The average disk utilization for successive full backups was around 70 percent.
  - The response time was reduced by more than half, to around 20 ms.

<table>
<thead>
<tr>
<th>Backup round</th>
<th>SQL server 2012 average CPU utilization</th>
<th>SQL server 2014 average CPU utilization</th>
<th>Data domain average CPU utilization</th>
<th>Data domain average disk utilization</th>
<th>Data domain average disk response time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday - Initial</td>
<td>28%</td>
<td>33%</td>
<td>49%</td>
<td>91%</td>
<td>43</td>
</tr>
<tr>
<td>Tuesday - Second</td>
<td>43%</td>
<td>50%</td>
<td>12%</td>
<td>68%</td>
<td>15</td>
</tr>
<tr>
<td>Wednesday - Third</td>
<td>45%</td>
<td>48%</td>
<td>13%</td>
<td>71%</td>
<td>16</td>
</tr>
<tr>
<td>Thursday - Fourth</td>
<td>41%</td>
<td>47%</td>
<td>13%</td>
<td>75%</td>
<td>21</td>
</tr>
<tr>
<td>Friday - Fifth</td>
<td>41%</td>
<td>53%</td>
<td>13%</td>
<td>76%</td>
<td>23</td>
</tr>
<tr>
<td>Weekend - Weekly</td>
<td>41%</td>
<td>51%</td>
<td>14%</td>
<td>76%</td>
<td>22</td>
</tr>
</tbody>
</table>

**Test results comparison with and without DD Boost**

We compared the test results for the second full backup with and without DD Boost. As shown in Figure 19, DD Boost reduced the data that was transferred across the network by over 93 percent.
Figure 19.  Key result comparison

Figure 20 shows the bandwidth results comparison. DD Boost not only improved the read bandwidth from XtremIO, but also reduced the write bandwidth to Data Domain.

Figure 20.  Bandwidth results comparison

Figure 21 shows the backup duration savings. DD Boost reduced the backup time of the second full backup for both SQL Server instances from 132 minutes to only 44 minutes.
Solution validation and testing

Figure 21. Backup duration results comparison

Based on the testing results, we can conclude that DD Boost is ideal for implementation in SQL Server database backup scenarios. DD Boost helps to:

- Increase the backup bandwidth from XtremIO
- Reduce the network bandwidth to Data Domain
- Improve the ingest rate of the Data Domain system
- Reduce the backup duration for SQL Server database full backups

SQL Server: Rapid, granular recovery

Test use case overview

This test use case is designed to show the recovery performance of NetWorker to restore SQL Server databases. It also shows the recovery function of Ontrack PowerControls, which provides table-level restoration for SQL Server databases.

Test objectives

This use case describes SQL Server recovery from Data Domain. We validated:

- NetWorker Module for Microsoft (NMM) plugin offers simplified, on-demand, quick recovery and restoration of databases from Data Domain through SSMS.
- Ontrack PowerControls for SQL Server provides agile table-level recovery.
Test method

We followed these steps to conduct the test:

1. Recovered a 500 GB database backup copy from one week ago using the NetWorker Module for Microsoft plug-in. Measured performance and captured metrics.

2. Recovered a table with 500,000 records through Ontrack PowerControls for SQL Server console. Measured performance and captured metrics.

Test results

SSMS database recovery with NMM plug-in

The NMM plug-in supports on-demand restoration for SQL Server databases and provides a restore panel in SSMS.

After installing the plug-in, in SSMS, we selected NetWorker > EMC NetWorker backup and selected Restore, as shown in Figure 22.

![Figure 22. Restore SQL Server database within NMM plug-in](image)

After NetWorker finished the weekly backup job, we restored the initial full backup from Data Domain. It took 21 minutes and 58 seconds to restore a 500 GB database from Data Domain to XtremIO, with an average recovery bandwidth of about 330 MB/s.

Table-level recovery with Ontrack PowerControls

Ontrack PowerControls for SQL Server offers a table-level recovery function to allow a finer granularity for database restoration and eliminate the need to mount the backup. The recovery steps are:
Solution validation and testing

1. Locate the source backup files and restore target of the database, as shown in Figure 23.

![Image of Table Recovery with Ontrack PowerControls]

Figure 23. Table recovery with Ontrack PowerControls

2. Query the backup directly, and select the table for recovery.

3. Restore tables with a drag-and-drop operation. Figure 24 shows the test table profile.

![Image of Test Table Profile]

Figure 24. Test table profile for PowerControls recovery

As shown in Figure 25, we selected the `dbo.FINANCIAL` table of DB4, and PowerControls completed the table restoration for 500,000 rows in only 59 seconds.
SQL Server: LTR backup test

Test use case overview
This test use case shows how CloudBoost together with ECS provides the option of low-cost LTR backup in a datacenter that minimizes resource consumption to SQL Server.

Test objectives
This use case describes a clone from NetWorker to ECS via CloudBoost. We validated:
* Feasibility of LTR of SQL Server databases using CloudBoost and ECS
* Data deduplication savings using ECS after each full backup job

Test method
We followed these steps to conduct the test:

1. In the NMC, located the saveset of the last weekly full backup and cloned it to the configured CloudBoost storage node as the first-week image.
2. Measured and captured the deduplication ratio for this clone.
3. Changed 30 percent of the data to simulate weekly operations using the SQL Server workload generator tool. Ran the back up to Data Domain and cloned the saveset to ECS. Measured and captured the deduplication ratio for this clone.
4. Repeated step 3 twice so that the backup images of the third and fourth week were stored on ECS. Then captured the deduplication ratio for each round of backups.
Table 14 shows the LTR backups that we tested for SQL Server databases in this solution.

Table 14. LTR backup rounds in this solution

<table>
<thead>
<tr>
<th>Backup round</th>
<th>Backup type</th>
<th>Backup target</th>
</tr>
</thead>
<tbody>
<tr>
<td>First week</td>
<td>Weekly full backup</td>
<td></td>
</tr>
<tr>
<td>Second week</td>
<td>Weekly full backup</td>
<td>Backed up to Data Domain, and then cloned to ECS via CloudBoost</td>
</tr>
<tr>
<td>Third week</td>
<td>Weekly full backup</td>
<td></td>
</tr>
<tr>
<td>Fourth week</td>
<td>Weekly full backup, also as monthly</td>
<td></td>
</tr>
</tbody>
</table>

Test results

The test results show the deduplication ratio of a 250 GB database by CloudBoost as captured on EMC Cloud Portal.

Table 15 shows the example database size and total backup data for each test round. We changed 30 percent of the data to simulate the workload of each week.

Table 15. Database size and total backup data for each test

<table>
<thead>
<tr>
<th>Backup round</th>
<th>Total dataset each backup (GB)</th>
<th>Actual backup size each backup (GB)</th>
<th>Data change ratio between each weekly backup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly backup (4 times)</td>
<td>250</td>
<td>203</td>
<td>30 percent, including update, insert, and delete operations</td>
</tr>
</tbody>
</table>

Figure 26 shows the deduplication ratio of an example database deduplicated by CloudBoost.

![CloudBoost Deduplication Ratio](image)

Figure 26. Deduplication ratio of clone to ECS via CloudBoost
With its deduplication ability, CloudBoost provides the option of inexpensive LTR of SQL Server data within the datacenter, which is a perfect complement to the effective backup provided by Data Domain. The key value CloudBoost offers is that the data is duplicated and compressed while minimizing the resource consumption (network bandwidth and cloud capacity) and maximizing cost savings.

ECS provides the most cost-effective cloud-based LTR platform for data protection workloads with its scalability, security, and fault-tolerance.

**Test use case overview**

This use case shows how NetWorker provides easy long-term recovery for SQL server from ECS via CloudBoost.

**Test objectives**

This use case describes long-term recovery from ECS via CloudBoost in NetWorker. We validated the use of the NNM plug-in. With help from ECS and CloudBoost, we recovered a SQL Server database from weeks or months ago.

**Test method**

We followed these steps to conduct the test:

In the previous backup retention to ECS use case, a 250 GB database was cloned to ECS via CloudBoost at a different timeline.

1. Recovered the 250 GB database backup copy of the third week stored on ECS through the NMM plug-in.
2. Recovered the 250 GB database backup copy of the first week stored on ECS through the NMM plug-in.

**Test results**

All past backup images are displayed under Restore in the NMM plug-in for SSMS, as shown in Figure 27, and are stored either short-term in Data Domain or long-term in ECS.
From the backup time attribute of the image, we located the images stored on ECS in the first week and third week. We then configure a pool for tail-log backup, started the recovery operation, and the database was recovered to the selected state.

With CloudBoost and ECS, you can recover backup images from weeks or months ago to a SQL Server database. This complements the Data Domain rapid recovery to a recent state. Compared with LTR to public-cloud object storage, ECS minimizes the risk of data security and low availability because the data is stored within the datacenter. The cost is similar for the two options.
Conclusion

Summary

This solution is designed for Microsoft SQL Server hybrid backup and recovery under both short-term and long-term use cases.

The combination of EMC NetWorker and EMC DD Boost helps to accelerate SQL Server short-term backup performance and provide agile and simplified recovery. By performing host-side assisted data deduplication with DD Boost, we reduced over 80 percent of network bandwidth and reduced the backup duration of SQL Server databases by over 60 percent. DD Boost also increased the ingestion rate of Data Domain by 2.7 times.

The combination of EMC NetWorker and EMC CloudBoost enables simple and quick backup protection to the cloud. CloudBoost offers a backup clone for SQL Server database backup to archive in a public or private cloud. Using CloudBoost to clone a database to ECS storage results in a 3 times deduplication ratio.

This solution validated the database recovery function of NetWorker Module for Microsoft SQL Server to restore a 500 GB database within 22 minutes, and validated the table-level restore using Kroll Ontrack PowerControls software to recover a production table of 500,000 rows within 1 minute.

Findings

The key findings of this solution are:

- EMC NetWorker and EMC Data Domain offer quick, highly efficient, and reliable backup protection for Microsoft SQL Server databases.
- EMC DD Boost improves SQL Server database backup performance through host-side assisted data deduplication after initial full backup by:
  - Reducing network bandwidth to Data Domain by over 80 percent
  - Improving Data Domain average ingest rate by 2.7 times
  - Reducing SQL Server database successive full backup durations by over 60 percent
- EMC NetWorker Module for Microsoft offers a comprehensive database recovery.
- Kroll Ontrack PowerControls for SQL Server offers a rapid, on-demand table-level recovery for databases of any size.
- EMC CloudBoost appliance enables long-term-retention copies onsite or offsite for SQL Server data.
- EMC ECS provides an inexpensive option for LTR of SQL Server data within a datacenter.
The following documentation on [EMC.com](http://EMC.com) or [EMC Online Support](http://EMC Online Support) provides additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your EMC representative.

- [Data Domain Operating System Administration Guide 5.7](#)
- [ECS 2.2 Planning Guide](#)
- [NetWorker 8.2 SP1 Installation Guide](#)
- [NetWorker Module for Microsoft Release 8.2 SP1 Installation Guide](#)
- [NetWorker 8.2 SP1 Administration Guide](#)
- [NetWorker Module for Microsoft for SQL VDI Release 8.2 SP1 User Guide](#)
- [NetWorker with CloudBoost 2.0 Integration Guide](#)