



Compellent Storage Center

SQL Server Disaster Recovery with Synchronous Replication

Solutions Guide

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Dell Compellent Technical Solutions Group
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4/29/2013	1.1	Doug Bernhardt	Incorporated review feedback

1 Preface

1.1 Audience

The audience for this document is System Administrators and/or Database Administrators who are responsible for the setup and maintenance of SQL Server and associated storage. Readers should have a working knowledge of Windows and the Dell Compellent Storage Center.

1.2 Purpose

This document provides an overview of using Dell Compellent Synchronous Replication with SQL Server and discusses some the considerations of choosing and implementing this technology. Additional information can be found at <http://kc.compellent.com> and in the additional resources listed at the end of this document.

1.3 Customer Support

Dell Compellent provides live support 1-866-EZSTORE (866.397.8673), 24 hours a day, 7 days a week, 365 days a year. For additional support, email Dell Compellent at support@compellent.com. Dell Compellent responds to emails during normal business hours.

2 Introduction

SQL Server is a world-class database platform used to run mission critical applications in all types of environments. These mission critical applications can require a disaster recovery (DR) solution that meets extremely low Recovery Time Objectives (RTO) and Recovery Point Objectives (RPO). The Synchronous Replication features in Storage Center 6.3 can help achieve these recovery objectives.

As with any disaster recovery solution there are tradeoffs in terms of capabilities, requirements, and performance. A complete disaster recovery solution will likely include a combination of various tools and technologies. Synchronous Replication can be a core component in this solution. It is important that you fully understand Synchronous Replication, how it works with SQL Server, and its role in your overall disaster recovery before designing and implementing a solution.

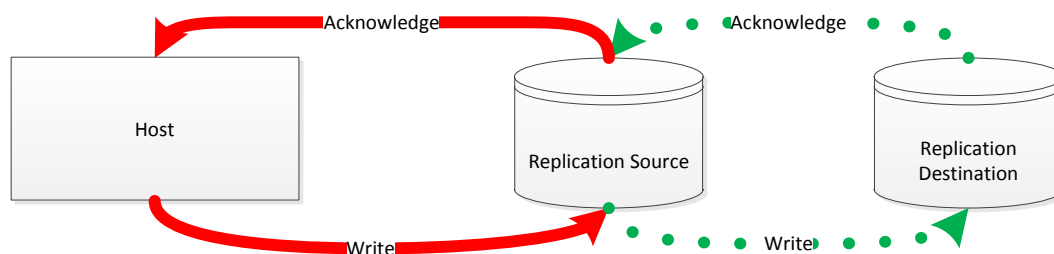
3 Synchronous Replication Overview

3.1 Replication Types

Although the focus of this paper is Synchronous Replication it is important to understand the types of replication offered. Storage Center supports two main types of replication, Asynchronous and Synchronous. Both of these are configured using the Dell Compellent Enterprise Manager application and each is briefly explained below.

3.1.1 Asynchronous Replication

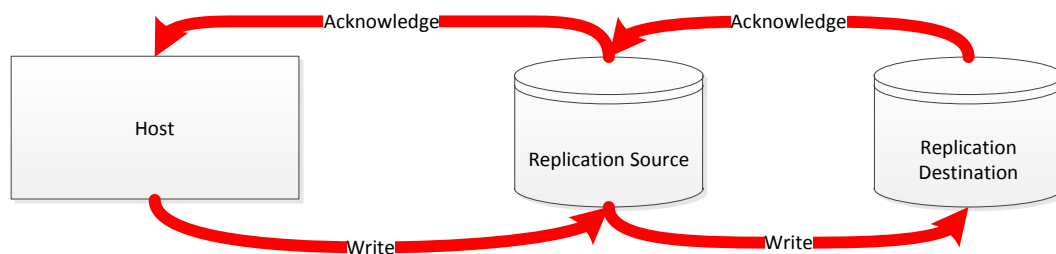
With Asynchronous Replication, writes are committed only at the source before the acknowledgment is sent to the Storage Center and then to the host. At some point those writes are forwarded to the destination volume, but they are not part of the storage transaction. The point at which they are forwarded to the destination volume depends on how Asynchronous Replication is configured. By default they are forwarded as soon as a replay is taken on the volume. If you choose the “Replicate Active Replay” option they are forwarded as soon as they are written to the source. This method of replication can support low RPOs but does not guarantee zero data loss. However, it can offer a lower Total Cost of Ownership (TCO). Because database transactions are independent of replication the performance requirements of the replication infrastructure are lower. In the diagram below the paths that impact latency are shown as solid lines.



A key benefit of Asynchronous Replication is that write latency is not directly affected by replication.

3.1.2 Synchronous Replication

With Synchronous Replication, the writes are committed and acknowledged by both the source and the destination volumes before the acknowledgement is sent to the host. This is similar to how a two-phase commit works in the database world, both have to be successful or neither is successful. This achieves the goal of zero data loss but sometimes a much higher TCO. Database transaction latency will be directly affected by replication latency and therefore a high performance replication infrastructure is desirable. Once again, in the diagram below the paths that affect replication are shown as solid lines.



Compared to Asynchronous Replication, notice that there are two additional paths that now impact write latency on the host.

For more information on either of these replication types please refer to the Enterprise Manager Administrator's Guide. The Synchronous Replication Solutions Guide also explains both replication types in further detail.

3.2 Modes of Operation – Synchronous Replication

As of Dell Compellent Storage Center 6.3 there are two different modes of operation for Synchronous Replication: High Consistency and High Availability.

3.2.1 High Consistency

High Consistency Synchronous Replication is considered true synchronous replication. For the writes to be successful they must succeed at both the source and destination volumes. It is important to note that an issue with any component that is participating in communication between the source and destination could cause a delay or outage to writes and potentially your application. High Consistency mode offers zero data loss and prioritizes data consistency over data availability. If zero data loss is required, even at the expense of applications being unavailable, then High Consistency mode may be the answer.

3.2.2 High Availability

High Availability Synchronous Replication provides high availability of the source volumes by guaranteeing that the writes at the source volumes will not fail due to replication issues. If the destination volumes become unavailable or replication latency becomes too high the dual write requirement will be removed and writes will be queued at the source until replication can catch up. Once replication is caught up the dual write requirement is once again enforced. High Availability mode prioritizes data availability over data consistency. If system availability is the priority, even at the small risk of data loss, then High Availability mode may be the answer.

4 Planning Synchronous Replication with SQL Server

4.1 Choosing what to replicate

Dell Compellent Storage Center and related tools such as Enterprise Manager and Replay Manager provide a great set of tools and options for building a custom disaster recovery solution. While there are a various options to choose from here are a couple of suggested ways that SQL Server could be protected using Synchronous Replication.

4.1.1 Data Only

The most basic way to protect the SQL Server Databases is to replicate only the user data of one or more databases. What this means is that only the volumes that contain data files and log files for user databases are replicated using Synchronous Replication. When activating the DR site, the database volumes are brought online and the databases are attached. Bringing the volumes online can be done manually or scripted. .

Some advantages of this method are:

1. Replication footprint is minimal and therefore requires fewer resources.
2. Destination server is online and able to be used for other activities
3. Destination configuration does not need to match the source configuration. Servers could be combined for efficiency.

Some disadvantages of this method are:

1. Other components of the destination server such as operating system, SQL Server logins, jobs, etc. need to be maintained by a separate process.
2. Additional configuration changes may be required at failover time such as database connection strings or server network configuration depending on your failover strategy.

4.1.2 All Volumes

Another option for protecting SQL Server Databases with Synchronous Replication is to replicate all volumes (with the exception of tempdb volume) to an offline server. When activating the DR site all volumes on the server are brought online. This includes taking advantage of the Storage Center Boot From SAN feature and replicating the boot volume as well. This allows for a standby server to have an identical configuration as the primary server with minimal configuration required.

Some advantages of this method are:

1. The scope of protection is expanded to the entire server

2. Since all server settings are being replicated the secondary server will have the same settings as the primary server.
3. Standby server is exact copy of primary server

Some disadvantages of this method are:

1. Need identical server at secondary site reserved for this purpose
2. Replication footprint is larger since more volumes need to be replicated
3. Need to support stretch network to allow same server network configuration to be used

4.2 Determining Bandwidth Requirements

A critical consideration in planning for Synchronous Replication is determining the bandwidth requirements for replication. This is critical for Synchronous Replication as insufficient bandwidth and/or bandwidth quality issues will cause performance issues and even outages depending on the mode of replication. Dell Compellent Enterprise Manager provides features to assist planning for replication. Using Enterprise Manager you can simulate any replication type and mode and then use IO Reports to assess the replication requirements. If you are satisfied with the simulation you can convert the simulation to real replication. Refer to the Storage Center Administrators Guide on Simulating Replications.

4.3 SQL Server Considerations

There are several factors regarding SQL Server configuration, database design and usage that can impact data replication resources. Those responsible for database architecture, design, and implementation should understand that the IO cost for replicated data is higher so they can plan accordingly. Architecture and design with replication in mind can make a huge difference in the amount of resources required to support replication or if replication is feasible in your environment. As with most changes the benefit will depend on your environment and it is important to test the overall impact to the system before implementing these recommendations.

4.3.1 Data Compression

Using Data Compression for SQL Server tables and indexes can improve both replication performance and overall IO performance. When Data Compression is used SQL Server compresses the data in memory resulting in fewer pages being stored on disk. Compressing the data requires additional CPU resources. The CPU cost of Data Compression as well as the storage savings depends on the type of compression, the data types used, and the actual data values. For more information on implementing Data Compression refer to the Additional Resources section at the end of this paper.

4.3.2 Instant File Initialization

Enabling Instant File Initialization for SQL Server is commonly used to reduce the amount of time required to create and expand data files. When this feature is enabled SQL Server skips

the process of “zeroing out” all data pages when a data file allocation occurs. Since this delay is created by IO, enabling this feature eliminates this IO cost. Keep in mind that this only applies to data files and you will experience the “zeroing out” of pages when allocating log files regardless. For more information on implementing Instant File Initialization with SQL Server refer to the Additional Resources section at the end of this paper.

4.3.3 Application Tuning

It is always a good idea to periodically review application code for inefficiencies and planning for replication can be another opportunity. Application tuning is arguably best investment for optimizing hardware resources and improving performance. It is not uncommon for a single code change to have an impact of 100% or more. For storage replication the tuning focus is to optimize database write activity. Using your favorite tuning tool or scripts examine your system to determine the largest producers of write activity and evaluate those for optimization.

4.3.4 File Layout

When creating SQL Server databases that will be replicated, start by following SQL Server Best Practices placing system, data, log, TempDB, and backup files on separate volumes. If you are combining replicated and non-replicated databases on the same system place them on separate volumes to eliminate unnecessary replication traffic. If databases have different replication priority or types consider placing these on separate volumes as well. This will allow greater control in tuning replication. For more information on SQL Server Best Practices or replication tuning refer to the Additional Resources section at the end of this paper.

4.3.5 TempDB

TempDB is a database that is used as a temporary workspace for SQL Server. A unique aspect of TempDB is that it is rebuilt each time SQL Server is started. Therefore, it is unnecessary to replicate TempDB. By placing TempDB on its own volume per best practices this volume can be exempted from replication. From an application standpoint make sure that TempDB is being used when appropriate such that work tables are being created in TempDB vs. users creating work tables in the user database. Also consider using the SORT_IN_TEMPDB option when rebuilding indexes to reduce the IO load on the data volume.

5 Replication Administration

5.1 Setup

This section provides a brief overview of the steps required to setup Disaster Recovery:

- Configure Replays using Replay Manager
- Replication Setup using Enterprise Manager
- Save Restore Points and Disaster Recovery Settings
- Activate the Disaster Recovery Site
- Reactivate the Production Site

The detailed steps to perform these tasks can be found in the Replay Manager Administrators Guide and the Enterprise Manager Administrators Guide.

5.1.1 Configure Replays using Replay Manager

The recommended first step in configuring a DR environment for SQL Server is to configure Replays for the SQL Server databases using Dell Compellent Replay Manager. Replays create a consistent synchronization point and the recommended method of taking Replays for SQL Server is to use Replay Manager. Replay Manager provides the Volume Shadow Copy Service (VSS) integration with SQL Server that allows the Replay process to first pause database IO so that a consistent Replay can be taken across multiple volumes.

5.1.2 Replication Setup using Enterprise Manager

The next step in setting up replication is to configure the volumes to be replicated in Enterprise Manager. Regardless of the type of replication the steps are the same, just selecting different options depending on the type. It is recommended that when you create your replications you start by Simulating Replications and then convert your replications to real replications. This provides an additional opportunity to verify your settings as well as the replication impact. Whether you create replications of simulations you will select the source and destination storage centers as well as the volumes you wish to replicate, the type (Asynchronous/Synchronous) and the mode (High Availability/High Consistency),

5.1.3 Save Restore Points and Disaster Recovery Settings

Once replication is setup it is recommended that you save and validate your Restore Points. This will save the information about replications. It is also recommended that you Predefine Disaster Recovery Settings. This will allow you to assign destination servers and replay profiles to destination volumes ahead of time rather than at recovery time.

5.2 Activate the Disaster Recovery Site

5.2.1 Test Activation

Another great feature of Enterprise Manager is the ability to Test Activate Disaster Recovery.

Performing a test recovery creates a recovery volume and maps it to the appropriate server without interrupting the original volume. This allows you to test your disaster recovery plan without interrupting live replication. It is recommended that you perform a test activation periodically to ensure the DR plan is accurate. Once you perform a test activation you perform the same steps of bringing target volumes online and attaching the databases just like an actual DR activation.

5.2.2 Activate Disaster Recovery

Activating Disaster Recovery follows the same steps as test activation. The key difference is that this is using the live data, not a copy and when you do this replication will be terminated. The activation steps are Activate Disaster Recovery, Bring Target Volumes Online, and Attach Databases.

5.2.3 Reactivating the Production Site

To reactivate the production site you simply configure replication from the DR site back to the old Production Site. When you setup replication you can choose an option to "Use Existing Volume". This will only replicate data since the last common replay, potentially saving a lot of time in the replication process depending on how long the two sites have been out of sync.

6 Conclusion

Synchronous Replication provided by the Dell Compellent Storage Center along with Replay Manager and Enterprise Manager provide a robust toolset to meet stringent RPO and RTO objectives for SQL Server applications. While Synchronous Replication can be a key part of a complete disaster recovery solution, several other components also need to be considered. Proper architecture and design of the entire system with disaster recovery in mind combined with Dell Compellent products can provide an outstanding disaster recovery solution.

7 Additional Resources

7.1 Dell Compellent Resources

- Home Page - <http://www.compellent.com>
- Knowledge Center - <http://kc.compellent.com>
- Synchronous Replication Solutions Guide – - <http://kc.compellent.com>
- HA/DR for SQL Server Using Compellent Tools - <http://kc.compellent.com/Published%20Documents/SQL%20DR%20Using%20Compellent%20Tools.pdf>
- Storage Center Administrators Guide - <http://kc.compellent.com>
- Microsoft SQL Server Best Practices - <http://kc.compellent.com/Published%20Documents/Microsoft%20SQL%20Server%20Best%20Practices.pdf>

7.2 Other Resources

- SQL Server Data Compression - <http://msdn.microsoft.com/en-us/library/cc280449.aspx>
- SQL Server Instant File Initialization - [http://msdn.microsoft.com/en-us/library/ms175935\(v=sql.105\).aspx](http://msdn.microsoft.com/en-us/library/ms175935(v=sql.105).aspx)
- Attaching SQL Server Databases - <http://msdn.microsoft.com/en-us/library/ms190209.aspx>