Performance

Microsoft Dynamics CRM 4.0

Improving Microsoft Dynamics CRM Performance and Securing Data with Microsoft SQL Server 2008

White Paper

Date: January 2009

**Acknowledgements**

Initiated by the Microsoft Dynamics CRM *Engineering for Enterprise* (MS CRM E2) Team, this document was developed with support from across the organization and in direct collaboration with the following:

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# Project Overview

Microsoft SQL Server® 2008 contains a variety of features that, when implemented properly, can improve the performance of a Microsoft Dynamics® CRM 4.0 implementation and secure the data within that deployment. These Microsoft SQL Server 2008 features include:

* Compression
* Filtered Indexes
* Sparse Columns
* Transparent Data Encryption
* Backup Compression

The MS CRM E2 team, working in conjunction with the Microsoft SQL Server team, recently completed a project that was designed to:

1. Evaluate the new scenarios that these Microsoft SQL Server 2008 features expose
2. Measure the performance impact of implementing these features, both singly and in selected combinations

This paper provides an overview of these Microsoft SQL Server 2008 features, together with benchmark results and recommendations for implementation. This document is organized into three sections, as described in the following table:

|  |  |
| --- | --- |
| Section | Description |
| Overview of Relevant SQL Server 2008 Features | Provides a high-level description of the SQL Server 2008 features that were included in the testing effort |
| Details of Performance Analysis | Provides detail about the database, workload, testing process and methodology, and hardware environment for the project |
| Testing Results and Recommendations | Provides results of the testing effort and recommendations about how when to use specific SQL Server 2008 features |

**Note**: For feature detail beyond that provided in this document, on MSDN, see *Microsoft* *SQL Server 2008 Books Online* at
<http://msdn.microsoft.com/en-us/library/ms130214.aspx>

# Overview of Relevant SQL Server 2008 Features

## Compression

Microsoft SQL Server 2008 supports ROW and PAGE compression for both tables and indexes.

**Note**: For more information about compressed tables and indexes in SQL Server 2008, on MSDN, in SQL Server 2008 Books Online, see *Creating Compressed Tables and Indexes* at
<http://msdn.microsoft.com/en-us/library/cc280449.aspx>

### ROW Compression

ROW compression maps a fixed length data type to variable length physical storage to save space used to store the data; basically, it compresses columns in the row. For example, a CHAR(100) column stored in a variable length storage format only uses up the amount of storage defined by the data.

With ROW compression enabled, storing "SQL Server 2008" in the column requires storing only 15 (no the full 100) characters, representing a savings of 85%. Also, with ROW compression enabled, storing zero or null values requires no storage space.

**Note**: For more information about ROW compression, on MSDN, in SQL Server 2008 Books Online, see *ROW Compression Implementation* at
<http://msdn.microsoft.com/en-us/library/cc280576.aspx>

### PAGE Compression

A superset of ROW compression, PAGE compression takes into account the redundant data in one or more rows on a page to save space used to store the data. PAGE compression uses column prefixes and a page level dictionary technique for this task. In other words, with both page compression techniques, the storage engine reduces the amount of data that is repeated in the page. To optimize performance, page compression only occurs when a page is full.

**Note**: For more information about PAGE compression, on MSDN, in SQL Server 2008 Books Online, see *PAGE Compression Implementation* at
<http://msdn.microsoft.com/en-us/library/cc280464.aspx>

## Filtered Indexes

A *filtered index* is an optimized nonclustered index that is especially suited for queries that select from a well-defined subset of data. Filtered indexes use a filter predicate to index a portion of rows in the table. Filtered indexes can provide advantages over full-table indexes.

**Improved query performance and plan quality**. Well-designed filtered indexes are smaller than full-table nonclustered indexes and have filtered statistics, which are more accurate than full-table statistics because they cover only the rows in the filtered index.

**Reduced index maintenance costs**. A filtered index is maintained only when data manipulation language (DML) statements affect data in the index. Maintenance costs are further reduced because filtered indexes are typically smaller than non-filtered indexes. The smaller size of filtered indexes also reduces the cost of updating statistics if the filtered indexes contain only frequently affected data.

**Reduced index storage costs**. Filtered indexes can reduce storage requirements for nonclustered indexes when a full-table index is not necessary. Replacing a full-table nonclustered index with multiple filtered indexes does not require significantly more storage.

**Note**: For more information about filtered indexes, on MSDN, in SQL Server 2008 Books Online, see *Filtered Index Design Guidelines* at
<http://msdn.microsoft.com/en-us/library/cc280372.aspx>

## Sparse Columns

*Sparse columns* are ordinary columns that have an optimized storage for NULL values. Sparse columns reduce the space requirements for NULL values at the cost of greater CPU overhead to retrieve not NULL values. Sparse columns and filtered indexes enable applications, such as Windows SharePoint Services, to efficiently store and access a large number of user-defined properties by using SQL Server 2008. Use sparse columns with column sets or filtered indexes.

**Column sets**. INSERT, UPDATE, and DELETE statements can reference the sparse columns by name. Additionally, you can also view and work with all the sparse columns of a table that are combined into a single XML column. This column is called a column set.

**Filtered indexes**. Because sparse columns have many null-valued rows, they are especially appropriate for filtered indexes. A filtered index on a sparse column can index only the rows that have populated values. This creates a smaller and more efficient index.

**Note**: Sparse columns and column sets are defined by using the CREATE TABLE or ALTER TABLE statements. For more information about sparse columns, on MSDN, in SQL Server 2008 Books Online, see *Using Sparse Columns* at
<http://msdn.microsoft.com/en-us/library/cc280604.aspx>

## Transparent Data Encryption

Transparent data encryption (TDE) is designed to provide protection for the entire database “at rest*”* without affecting existing applications. Implementing encryption in a database traditionally involves complicated application changes such as modifying table schemas, removing functionality, and significant performance degradations.

TDE solves these problems by simply encrypting everything while being transparent to the application. Thus, all data types, keys, indexes, and so on can be used to their full potential without sacrificing security or leaking information on the disk. While column or cell-level encryption cannot offer these benefits, two Windows® features, Encrypting File System (EFS) and BitLocker™ Drive Encryption, are often used for the same reasons as TDE; they provide protection on a similar scale and are transparent to the user.

With similar functionalities to that in EFS or BitLocker Drive Encryption technology, TDE also provides the following advantages:

* TDE is *sticky*, so files are encrypted as they are detached or backed up
* A Windows administrator is not required to enable encryption; the task is associated with the database administrator, reducing redundant administrator workload
* All database encryption is managed by SQL Server

**Note**: For more information about transparent data encryption, see the MSDN SQL Server 2008 Technical Article *Database Encryption in SQL Server 2008 Enterprise Edition* at
<http://msdn.microsoft.com/en-us/library/cc278098.aspx>

## Backup Compression

Because a compressed backup is smaller than an uncompressed backup of the same data, compressing a backup typically reduces device I/O and therefore usually increases backup speed significantly.

**Important**: Creating compressed backups is supported only in SQL Server 2008 Enterprise edition and later versions, but every edition of SQL Server 2008 and later versions can restore a compressed backup. Also, backup compression is not recommended to be used in conjunction with TDE.

**Note**: For more information, on MSDN, in SQL Server 2008 Books Online, see *Backup Compression (SQL Server)* at
<http://msdn.microsoft.com/en-us/library/bb964719.aspx>

# Details of Performance Analysis

The project involved enabling certain SQL Server features on a Dynamics CRM database and then evaluating the impact of those changes by using benchmarks or other means. To capture the data profile of a typical CRM customer, the database used in the benchmark contained both customer and generated data. To simplify the process of measuring the performance impact, benchmark testing efforts focused on the Accounts table. Similar levels of performance impact are expected across all CRM entity tables.

## Database

The database used in the testing was partially populated with real customer data and partially generated. Additional characteristics of the database tested include:

* 15.5 GB physical size
* 200 users
* Over 2 million Accounts

## Workload

The Dynamics CRM 4.0 Performance Toolkit was used to execute the benchmark. To generate a 200-concurrent user Account Management application workload, we used the following test cases in the toolkit:

* Create Account
* Find Account
* Update Account
* Delete Account
* Advanced Find on Account

## Testing Process and Methodology

Testing evaluated each feature independently, as well as selected features in combination. We used the same methodology in testing each scenario, with the exception of enabling Backup Compression, for which we measured the time and space required for an uncompressed backup versus a compressed backup.

Methodology

1. Execute baseline benchmark
2. Modify the database for each scenario:
	1. Compression
	2. Filtered Indexes
	3. Sparse Columns
	4. Filtered Indexes and Sparse Columns
	5. Filtered Indexes and ROW Compression
	6. TDE
3. Re-index CRM database (if necessary)
4. Measure impact on table size
5. Execute benchmark

## Hardware Environment

The hardware environment reflected a three-Server CRM deployment and a single test computer, which were configured as shown below.

**CRM Server 4.0**

* Dual Proc Intel® Xeon® CPU 2.33 GHz
* 16 GB RAM
* Windows 2008 64-bit

**SQL Server 2008**

* Dual Proc Intel® Xeon® CPU 2.33 GHz
* 16 GB RAM
* Windows 2008 64-bit

**Domain Controller**

* Dual Proc Intel® Xeon® CPU 2.33 GHz
* 16 GB RAM
* Windows 2008 64-bit

**Test Computer**

* Visual Studio 2005 Test Suite with Dynamics CRM 4.0 Performance and Stress Testing Toolkit
* Dual Proc Intel® Xeon® CPU 2.33 GHz
* 16 GB RAM
* Windows 2008 64-bit

# Testing Results and Recommendations

## Improving Performance by Using SQL Server 2008 Compression

Columns in Dynamics CRM tables are typically sparsely populated, which our analysis of the customer database used in the testing efforts confirmed. Except for certain columns such as Account ID, Name, Phone Number and Email Address, the Account table was sparsely populated. Both row and page compression are also very effective on CRM entity tables, which also contain a lot of binary columns and columns that specify pick list values.

### Results - Row Compression

Benchmark testing indicated that row compression results in significant improvement in application performance as well as a substantial savings in space requirements.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ Row Compression** |  | **Percent Change** |
| **Data (KB)** | 2733672 | 1949464 |  | ***-28.69*** |
| **Index (KB)** | 1899000 | 1903088 |  | *0.22* |
| **Avg. resp. time (sec)** | 1.3775 | 0.90 |  | ***-35.03*** |
| **SQL Util. (%)** | 21.575 | 16.80 |  | ***-22.13*** |
| **Web Util. (%)** | 2.135 | 2.01 |  | ***-5.74*** |

### Results - Page Compression

Page compression proved to be the best option if space is at a premium. While application performance was roughly the same with or without page compression enabled, implementing page compression resulted in a reduction in space requirements by over 80%!

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ Page Compression** |  | **Percent Change** |
| **Data (KB)** | 2733672 | 507072 |  | ***-81.45*** |
| **Index (KB)** | 1899000 | 1905552 |  | *0.35* |
| **Avg. resp. time (sec)** | 1.3775 | 1.43 |  | *3.81* |
| **SQL Util. (%)** | 21.575 | 19.44 |  | ***-9.90*** |
| **Web Util. (%)** | 2.135 | 2.03 |  | ***-4.92*** |

### Recommendations

When considering the use of SQL Server 2008 Compression to improve the performance of a Microsoft Dynamics CRM 4.0 implementation, keep in mind the following recommendations:

1. Identify the largest tables in the Dynamics CRM database and consult SQL Server best practices to pick the best candidates for compression.

**Note**: Dynamics CRM tables (such as metadata tables) that are very frequently accessed or continuously updated may not be good candidates for compression. An example is the PrincipleObjectAccess table which manages the privileges for the CRM system. In these cases, the performance impact of managing these compressed tables may outweigh the space savings from compression.

1. Estimate savings for each table by using the following stored procedure
*sp\_estimate\_data\_compression\_savings*
2. Enable Page Compression on tables with mostly static data.
3. Enable Row Compression on entity tables.
4. Verify performance impact.

**Important**: Compressing every table in the database may put a lot of load on the SQL Server and compression should be limited to large tables as per SQL Server best practices.

#### Note: For additional information about compression strategies in SQL Server 2008, on the MSDN Developer Blog, as part of the information related to the SQL Server Storage Engine, see the entry *Compression Strategies* at<http://blogs.msdn.com/sqlserverstorageengine/archive/2008/01/27/compression-strategies.aspx>

## Improving Performance by Using SQL Server 2008 Filtered Indexes

Analysis of Dynamics CRM customer workloads shows that one of the most common user actions is to load the entity grids. This action loads between 25 and 200 entities (based on the user’s setting) and displays them in the UI. The user can also specify the view they want to use for accessing the data or create a custom view. The Dynamics CRM application creates indexes on the SQL Server tables to optimize the user experience; and customers can also create new indexes to map to their custom views. Filtered indexes allow Dynamics CRM Administrators to map these indexes better to the views.

As an example, a custom view called “My Accounts - Basic” displays the Account Names for all Accounts owned by the current user where State Code is 0. The AccountBase table has an index on Account Name. One solution would be to extend the index (or create a new one) to include State Code. Accounts with non-zero State Codes are however never accessed, but SQL Server still has to maintain the index for these Accounts. A better solution is to modify the index (or create a new filtered index) to restrict the index to Accounts where State Code = 0. This allows SQL to only maintain the index on a subset of data in the table.

### Results

For our testing, we created a Filtered Index on the Account Name where State Code and Deletion Code are 0. While creating the additional index increased the amount of space required for the table, both application performance and SQL Server SPY utilization improved significantly.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ Filtered Indexes** |  | **Percent Change** |
| **Data (KB)** | 2733672 | N/A |  | *N/A* |
| **Index (KB)** | 1899000 | 2432680 |  | *28.10* |
| **Avg. resp. time (sec)** | 1.3775 | *0.94* |  | ***-31.58*** |
| **SQL Util. (%)** | 21.575 | 18.97 |  | ***-12.09*** |
| **Web Util. (%)** | 2.135 | *2.41* |  | *12.65* |

### Recommendations

When considering the use of SQL Server 2008 Filtered Indexes to improve the performance of a Microsoft Dynamics CRM 4.0 implementation, keep in mind the following recommendations:

1. Use SQL Server 2008 Data Management Views or SQL Server Profiler to identify the following queries while the system is in production:
	* Most frequently executed queries
	* Longest running queries
2. Analyze the queries and identify any static conditional statements that can be used to filter the indexes.
3. Create a new filtered index to address each query as necessary, based on SQL Server best practices.
4. Identify the most frequently executed and longest running SQL Server queries again to verify the improvement in execution time.

## Improving Performance by Using SQL Server 2008 Sparse Columns

As mentioned, columns in Dynamics CRM tables typically are sparsely populated. The sparse columns feature in SQL 2008 is perfectly suited for Dynamics CRM tables because it reduces the space required to store data in user-specified columns. In addition, by setting the columns as sparse, Dynamics CRM administrators can optimize access to frequently accessed tables in which certain columns are rarely accessed and include all or mostly NULL values.

Benchmark testing on the Account table demonstrated significant improvements in space requirements and application performance. Using the guidance provided by the SQL Server best practices that are documented in the upcoming release of the whitepaper *Semi-structured Data Management in SQL Server 2008*, we marked 36 of the 83 columns in the AccountBase table as sparse.

**Note**: SQL Server CPU utilization would have improved even more if the server running SQL Server had been memory limited. The computer running SQL Server in the benchmark testing had 16 GB of RAM and the database was 15.5 GB, so therefore over the course of testing the entire Account table was resident in memory.

### Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ Sparse Columns** |  | **Percent Change** |
| **Data (KB)** | 2733672 | 2244160 |  | ***-17.91*** |
| **Index (KB)** | 1899000 | 2086696 |  | *9.88* |
| **Avg. resp. time (sec)** | 1.3775 | 1.03 |  | ***-25.23*** |
| **SQL Util. (%)** | 21.575 | 19.64 |  | ***-8.97*** |
| **Web Util. (%)** | 2.135 | 2.05 |  | ***-4.22*** |

### Recommendations

Designating a column as sparse is only useful when the column contains mostly NULL values; consider using sparse columns when the space saved is at least 20 percent to 40 percent to strike a balance between space savings and additional CPU overhead. As you work to improve Microsoft Dynamics CRM 4.0 performance by using SQL Server 2008 Sparse Columns, keep in mind the following recommendations:

1. Identify large tables in the Dynamics CRM database.
2. Consult SQL Server best practices documented in the white paper (above) to select the columns to be marked as sparse; typically, use sparse storage for columns in which most values are NUL

**Note**: Marking non-sparse columns as sparse will significantly increase the amount of space needed to store the data.

1. Mark the columns as sparse and rebuild the indexes on the table.
2. Verify performance impact.

## Improving Performance by Using Filtered Indexes and Sparse Columns

We also tested a configuration that used filtered indexes in conjunction with sparse columns, which SQL Server documentation typically recommends more frequently than a configuration that combines the use of filtered indexes and row compression.

**Note**: While CRM application performance improves in this scenario, there is an additional cost for identifying and managing the sparse columns over the lifecycle of the CRM deployment.

### Results

Results confirmed the performance improvements yielded by using filtered indexes, while implementing sparse columns offset some of the additional space requirements associated with filtered index functionality.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ F-Index + S-Cols** |  | **Percent Change** |
| **Data (KB)** | 2733672 | 2245112 |  | ***-17.87*** |
| **Index (KB)** | 1899000 | 2392640 |  | *25.99* |
| **Avg. resp. time (sec)** | 1.3775 | 1.09 |  | ***-20.87*** |
| **SQL Util. (%)** | 21.575 | 20.04 |  | ***-7.11*** |
| **Web Util. (%)** | 2.135 | 1.98 |  | ***-7.26*** |

### Recommendations

Use the combination of filtered indexes and sparse columns in scenarios where the CRM database includes tables with a very large number of columns, most of which are sparse.

**Important**: Sparse columns and compression cannot be used on the same table.

## Improving Performance by Using Filtered Indexes and ROW Compression

### Results

Using filtered indexes in conjunction with ROW compression yielded both performance improvements and space savings.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ F-Index + Row Comp.** |  | **Percent Change** |
| **Data (KB)** | 2733672 | *1949512* |  | ***-28.69*** |
| **Index (KB)** | 1899000 | *2196664* |  | *15.67* |
| **Avg. resp. time (sec)** | 1.3775 | *1.00* |  | ***-27.16*** |
| **SQL Util. (%)** | 21.575 | *19.14* |  | ***-11.29*** |
| **Web Util. (%)** | 2.135 | *2.40* |  | *12.18* |

### Recommendations

Customers should consider using Filtered Indexes in conjunction with Row Compression as an alternative to using Filtered Indexes and Sparse Columns. The advantage of this alternative is the low cost of management as there is no need to identify and manage the sparse columns across all the large tables in the deployment.

## Securing Microsoft Dynamics CRM Data by using SQL Server 2008 Transparent Data Encryption

TDE impacts how the data is stored on disk. The test database was approximately 15.5 GB and the computer running SQL Server was configured with 16 GB of RAM.

### Results

After the data is decrypted and loaded into memory, application performance was the same as the performance without encryption. To measure the actual impact of TDE, we flushed the SQL Server buffer pool and data cache before every run to ensure that data is loaded from disk. Results demonstrate that with TDE enabled, first-run application performance experienced a slight (less than 10%) degradation in performance. As expected, SQL Server CPU utilization was also higher as a result of the overhead associated with decrypting the data on disk during the initial run. With the data already decrypted and loaded into memory, subsequent runs yielded results similar to the baseline figures.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Baseline** | **w/ Trans. Data Encrypt.** |  | **Percent Change** |
| **Data (KB)** | 2733672 | *2733928* |  | *0.01* |
| **Index (KB)** | 1899000 | *1900616* |  | *0.09* |
| **Avg. resp. time (sec)** | 1.3775 | *1.50* |  | *8.71* |
| **SQL Util. (%)** | 21.575 | *24.13* |  | *11.82* |
| **Web Util. (%)** | 2.135 | *2.09* |  | ***-2.34*** |

**Note**: We verified that the database files were not readable via a hex editor after encryption.

### Recommendations

For business scenarios that require a level of protection for the entire database at rest, consider enabling TDE, which test results confirm will have a minimal affect on the performance of existing applications.

## Performing and Maintaining Backups More Efficiently by Using SQL Server 2008 Backup Compression

As expected, results confirmed that enabling Backup Compression yields significant savings in the time required to perform backups and in the space required for storing those backups.

### Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Uncompressed** | **Compressed** |  | **Percent Change** |
| **Backup Time (min)** | 9:03:09 | 2:38:51 |  | ***-70.75*** |
| **Backup Size (Kb)** | 12299686 | 2791721 |  | ***-77.03*** |

**Note**: The size of the database used in this test was 15.5 gigabytes.

### Recommendations

Enable backup compression to increase the efficiency of performing and maintaining backups. However, keep in mind that compression can significantly increase CPU usage and that the additional overhead might adversely impact concurrent operations. As a result, when using backup compression, be sure to verify that the overall system performs at desired levels. Additionally, consider creating low-priority compressed backups in a session whose CPU usage is limited by Resource Governor.

**Note**: For more information, on MSDN, see *How to: Use Resource Governor to Limit CPU Usage by Backup Compression (Transact-SQL)* at
<http://msdn.microsoft.com/en-us/library/cc280384.aspx>

# Summary

In summary, the results of our testing efforts demonstrate that the SQL 2008 features we evaluated can significantly improve the application performance of both SQL Server 2008 and Dynamics CRM 4.0 while resulting in space savings. While our testing focused exclusively on the Accounts entity, we would expect similar results across all CRM entities.

In addition, deploying these features does not require invasive infrastructure changes, and the features are easily enabled and disabled.

Based on the project results, it is recommended that customers use the information contained in this document, together with best practices defined in the SQL Server 2008 documentation, to take full advantage of the potential efficiencies in performance and space utilization that these features can offer.

**Important**: Be sure to verify the performance gains of making specific changes to the configuration of your CRM implementation.

# Appendix A: Resources

The following resources contain additional information about improving Microsoft Dynamics CRM performance and securing data with by using selected features in Microsoft SQL Server 2008.

* *Microsoft SQL Server 2008 Books Online*<http://msdn.microsoft.com/en-us/library/ms130214.aspx>
* *Creating Compressed Tables and Indexes*<http://msdn.microsoft.com/en-us/library/cc280449.aspx>
* *ROW Compression Implementation*<http://msdn.microsoft.com/en-us/library/cc280576.aspx>
* *PAGE Compression Implementation*<http://msdn.microsoft.com/en-us/library/cc280464.aspx>
* *Filtered Index Design Guidelines*<http://msdn.microsoft.com/en-us/library/cc280372.aspx>
* *Using Sparse Columns*<http://msdn.microsoft.com/en-us/library/cc280604.aspx>
* *Database Encryption in SQL Server 2008 Enterprise Edition*<http://msdn.microsoft.com/en-us/library/cc278098.aspx>
* *Backup Compression (SQL Server)*<http://msdn.microsoft.com/en-us/library/bb964719.aspx>
* *How to Use Resource Governor to Limit CPU Usage by Backup Compression (Transact-SQL)*<http://msdn.microsoft.com/en-us/library/cc280384.aspx>