High Availability Solution Database Mirroring in SQL Server 2008 R2

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I am Mustafa El-Masry Senior Database administrator and DB Analyst I am Expert Database performance tuning, I have deep practical knowledge about T-SQL performance, HW Performance issues, Data Warehousing and data mart solutions, SQL Server Replication, Clustering solutions (Active Active and active passive) and Database Designs for different kinds of systems, HAG, diving deeply more:
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More than +175 Post in SQL Server Technology: http://sqlserver-performance-tuning.net/?p=4526
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Introduction and overview
Database mirroring is a primarily software solution for increasing database availability. Mirroring is implemented on a per-database basis and works only with databases that use the full recovery model. The simple and bulk-logged recovery models do not support database mirroring. Therefore, all bulk operations are always fully logged. Database mirroring works with any supported database compatibility level. Database mirroring is used by Microsoft SQL Server, a relational database management system (RDBMS) designed for the enterprise environment. Two copies of a single database reside on different computers called server instances, usually in physical locations separated by some distance. The principal (or primary) server instance provides the database to clients. The mirror (or secondary) server instance acts as a standby that can take over in case of a problem with the principal server instance.
Reference
Note

- In database mirroring section you have 3 servers (principle, mirroring, and witness)
- The database will be in the principle server and the application will be connect to the principle server then you will take backup (Full + log) from the database in the principle server the make restore to this backup with no recovery option in the mirroring server so the record will copy from the principle server to the mirror server.
- Witness server will be monitoring to the principle and the mirroring server.
- You can setup the principle server in domain and the mirroring server in another domain

What happens if the principle server down in high availability mode?

If the principle server down the mirroring server will be the new principle server and the application will be connect automatically to the new principle server (mirroring server)

What happened when the application connect to the database in the principle server?

When the Application connect to the principle server and users make any transaction on this database the record will write in log puffer memory in principle server then write it in log file in database then the
log puffer send the record to the log puffer memory to the mirroring server then the log puffer write this record in log file in database. Then the mirror server send to the principle server massage to know the principle the transaction is succeed then the principle tell the application the transaction is succeed.

Database mirroring operation mode

You can setup the mirroring server in 3 modes

1. **High availability.**

In high availability you need 3 servers (principle server, mirroring server, witness server) so in this operation mode the application connect on the principle server then the transaction write in log file then the principle server send the record to the mirror server in log file then the mirror send to the principle (the record is commit) then the principle send to the application the transaction is committed.

2. **High safety.**

In high safety mode we don't need to the witness server we will need in this section to the principle server and the mirror server only so there's no automatic failover in high safety mode. And the operation will be same in the high availability mode [application connect on the principle server then the transaction write in log file then the principle server send the record to the mirror server in log file the mirror send to the principle (the record is commit) then the principle send to the application the transaction is committed]

**Remarks:** the difference between high availability mode and high safety mode is Automatic failover in high availability will found Automatic failover but in high safety will not found Automatic failover. So if the principle server down you have problem because you will make manually start

The mirroring server to be principle server. Not like in high availability mode this operation make automatically because this operation mode have automatic failover.

3. **High performance.**
In high performance mode you need 2 server (principle server, mirror server) like high safety mode. So the difference between the high performance mode and high safety mode is in high performance the application send the transaction to the principle server in log file then the principle send the record to the mirror server and send to the application the transaction is committed so the principle server don't wait the mirror server like (high safety mode and high availability mode).

<table>
<thead>
<tr>
<th>Operation mode</th>
<th>servers</th>
<th>Automatic failover</th>
<th>Principle wait the mirror</th>
</tr>
</thead>
<tbody>
<tr>
<td>High availability</td>
<td>3 servers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>High safety</td>
<td>2 servers</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>High performance</td>
<td>2 servers</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

In the finale I explain what is mirroring?, what is the operation mode in mirroring?, what is the difference between operation mode in mirroring?, remember I tell you high safety and high performance not need witness server but you can create witness server in this operation mode but it will make problems with you so don't make witness server in high safety mode and high performance mode.
Database Mirroring Requirement

- The database and file location should be same.
- Collection and master code page should be same in the principle and mirror server.
- Database name should be same in the principle and mirror server.
- You cannot mirror more the 10 databases in 32 bit servers you can in 64 bit server but not recommended.
- You cannot use attach/de attach you can use backup and restore.
- Ports in mirroring should be opening in firewall or close the firewall.
- Services account In SQL and SQL agent should be same in all servers.
- The mirroring not support the cross database transaction & distributed transaction log
- SQL server number should be same but you can setup principle server on SQL Server 2008 service pack 1 and the mirror on SQL Server service pack 2.

Advantage of Database Mirroring

1- Does not require special hardware (such as shared storage, heart-beat connection) and cluster ware, thus potentially has lower infrastructure cost
2- Database mirroring supports full-text catalogs
3- Hardware and software upgrade that's very easy.

**Remark:** If you want upgrade the mirror server from SQL server 2008 R2 to denial you must pass the mirroring in this section then after upgrade start the mirroring again
4- Increases the data protection (disaster recovery).
5- Increases the database availability if you use the Sync mode.
6- Cost of database mirroring is less than clustering.
7- It's robust and efficient than log shipping and replication.
8- Failover is fast compare to cluster
9- Mirror server can be used to host databases for other applications not like clustering.
Disadvantage of Database Mirroring

1- Mirroring doesn't support file stream.

2- Mirror server is not available for database read only.

3- Mirror server working in database level not in server level not like clustering (in clustering failover you make this in server level on all database in this server in logins in jobs like this)

Database Mirroring Enhancement in SQL Server 2008

1) **Database mirroring automatic page repair.**
   - If a page on the principle or mirror server is corrupt, it is automatically replaced with the corresponding copy on its partner
   - Some page types cannot be automatically repaired:
     - File header pages
     - Database boot page
     - Allocation pages

2) **Compressed Data flow**
   - Data Flow between the principle and mirror server is now compressed to improve performance.

3) **Manual Failover**
   - Manual failover no longer require a database restart

4) **Log performance**
   - log-send buffers
   - Page read-ahead
   - Write-ahead on the incoming log stream on the mirror server


Database Mirroring Installation Step by Step

Let's start to setup mirroring server in SQL server 2008 R2 in the first I will setup SQL Server 2008R2 with three instance
1. Principle instance (SQLSERVER2008R2A)
2. Mirroring instance (SQLSERVER2008R2B)
3. Witness Instance (SQLSERVER2008R2C)

- In my example I will make mirroring type high availability (Synchronize mode)
- In principle server I will create database Mirroring_DB
- Take full backup Mirroring_DB.bak
- then take log Transaction backup Mirroring_DB.trn
- Make restore to this backup full mirroring server with No recovery option
- Then right click on Mirroring_DB >>Tasks>>Restore>>Transaction Log
- Then Select your transaction log backup (Mirroring_DB.trn )
- Don’t forget restore with no recovery option

High Availability Mode [Automatic Failover]
Right click on database Mirroring_Db >> tasks >> Mirror >> Configure Security

You will ask if you want to setup witness server or not? select yes.

Then you will ask to select your principle server [connect to Elmasry-PC\Principle] and make the port is 5021 and the endpoint name is Principle then Click next

You will ask again to select your Mirroring server [connect to Elmasry-PC\Mirroring] and make the port is 5022 and the endpoint name is mirroring then click next.

You will ask again to select your witness server [connect to Elmasry-PC] and make the port is 5023 and the endpoint name is Witness then click next.

In this step he will ask you to put your user name in your windows and this user must be add in the SQL Server so I write my username is [my pc name\windows username] [Elmasry-PC\Elmasry] .then click finish

SQL server after you click finish it will make configuration to the Principle Server , Mirroring Server , Witness Server

After this configuration is finish SQL server will give you massage if you want to Start mirroring or not select start and Waite few mints then mirroring will start and you see the status is [Synchronized: the databases are fully synchronized]

Now go to make refresh to the servers [principle - mirroring]
Principle Server [Elmasry-PC\Principle]

1. Create Table Name Employee

   ```
   CREATE TABLE Employee
   (Emp_Id INT NOT NULL PRIMARY KEY IDENTITY,
   Emp_Name NVARCHAR(50) NOT NULL,
   Tel NVARCHAR(12) NULL)
   ```

2. Insert data in this table

   ```
   INSERT INTO dbo.Employee
   (Emp_Name, Tel)
   VALUES (N'Mostafa', -- Emp_Name - nvarchar(50)
   N'0172788327' -- Tel - nvarchar(12)
   ), ( 'Mohamed', '015876565645')
   ```

3. Now if you select data from Employee Table you will see 2 rows

4. Right click on the principle server and make stop to the server

Mirroring Server [Elmasry-PC\Mirroring]

1. Refresh the server (you will see the database change from mirroring to principle database and if you open the database you will see the Employee table and the 2 rows

2. Now try to insert in this table another 2 rows
INSERT INTO dbo.Employee
  ( Emp_Name, Tel )
VALUES ( N'Omar', -- Emp_Name - nvarchar(50)
  N'0172788327' -- Tel - nvarchar(12)
  ), ( 'Kemo', '015876565645' )

3- Stop the server and start the principle server [Elmasry-PC\Principle] you will see the database is mirroring make stop to the Mirroring server [Elmasry-PC\Mirroring] you will see the difference the mirroring database in the principle server will change to Principle sever and if you open the Employee table you will see 4 rows not 2 because the 2 rows you insert into database in mirroring server transfer automatically to another server

Before I start to explain Mirroring High Safety mode I will explain something is very good that’s is manual Failover Yes you can make manual failover in the previous Example I make Failover (meaning change the server principle will be the mirroring and the mirroring will be the principle) I make this operation but Automatically when I make stop to the server and this operation make Automatically because I make mirroring [High Availability] but in the manual failover you can make the same operation by your hand :

1- Go to principle server then right click and select tasks >>> Mirror

2- Then Click on Failover you will see the massage Click yes

3- Then make refresh to the server you will see the change
High Availability Mode [Manual Failover]

Before I start to explain Mirroring High Safety mode I will explain something is very good that’s is manual Failover Yes you can make manual failover in the previous Example I make Failover (meaning change the server principle will be the mirroring and the mirroring will be the principle) I make this operation but Automatically when I make stop to the server and this operation make Automatically because I make mirroring [High Availability] but in the manual failover you can make the same operation by your hand:

- Go to principle server then right click and select tasks >>> Mirror
- Then Click on Failover you will see the massage Click yes
- Then make refresh to the server you will see the change
High Safety Mode Without witness server [Manual Failover]

In High safety mode if the principle server down the mirroring will be disconnect but if you want to make the mirroring DB is principle DB in high Availability SQL Server make this operation Automatically because in this mode you have Automatic Failover but don’t worry you can make this by code [I listen someone tell me Why we can't make the mirroring is principle by Manual failover I tell him because the mirroring mode is high safety and the principle server is down so the mirroring server is disconnected so if you make right click on the mirroring DB then Select tasks then mirror you will see the button of Failover is Disable] so we have one choice or one way to make the Mirroring DB is principle DB to allow the application to connect This Way is By Code let’s start to explain the Mirroring [High Safety Mode]

Principle Server [Elmasry-PC\Principle]

1- Right click on mirroring database >>>> tasks >>>> Mirror
2- Delete the server network address to the witness server. automatic you will see the SQL server change your mode from high availability mode to high safety mode >>>>> click ok .
3- Right click on the principle server >>>>> then select stop .
4- The server will be down

Mirroring Server [Elmasry-PC\Mirroring]

1- Refresh the Mirroring Server
2- You will see the database [Mirroring_DB] is Disconnected/in recovery.
3- Now I will Execute SQL Statement on master database in mirroring sever this statement will change the mirroring_DB from mirror to principle

```sql
USE master
GO
ALTER DATABASE Mirroring_DB SET PARTNER FORCE_SERVICE_ALLOW_DATA_LOSS
```

4- If you make start to the Principle server [Elmasry-PC\Principle] you must go to the Mirroring Sever and right click on Mirroring_Db >>>Tasks >>>Mirror >>> Make resume to return the mirror to work.

5- High Performance Mode like High Safety mode but if you want to know the difference between high safety mode and high performance mode see part no 1

**Stander listener port in database mirroring**

If we will build the entire instance (Principle, mirroring, Witness) in the same server at this time you should use difference ports Example:

- Principle Server use the Stander port number 5021
- Mirroring Server use the Stander port number 5022
- Witness Server use the Stander port number 5023

But if you will build it in difference servers you can use one port like: 5021 but don’t forget to Disable Firewall or must be open these ports on the Firewall.

**Check SQL server mirroring availability**

We can check SQL Server mirroring is running or by difference steps:
Database Administration Community (https://mostafaelmasry.wordpress.com)

1- **port number listener**: open CMD and write this Command “netstat -an” you will see the 3 port for the 3 Servers Principle – mirroring – Witness also I see the 3 port because I setup the 3 SQL Server Instance in the same Windows Server

![Command output showing active connections](image)

2- Event Viewer for Windows Server
3- SQL Server Database Log

4- Check Endpoint Status
Add or replace witness server to an existing mirroring database

After I finish my work in Database Mirroring with operation Mode (high Safety), i explorer it will not be Automatic failover because this option if you need it you must configure your mirroring with operation mode (High Availability Synchronous) and this Operation Mode need 3 Servers (Principle, Mirroring, Witness) So i will Show now how to add or Replace mirroring Database Witness Server

1- Now this my mirroring operation mode it's high safety without automatic and the witness Server not configured.

2- Click on Configure Security after this mirroring will Ask you if you need to Configure Witness Server or not Select yes
3- Check Witness Server

4- Mirroring will return the principle server configuration
5- Select Witness Server

6- Configure Witness Server and the port listener
7. Put Services Account in my experience if you working in Workgroup and your all instance in the same windows like this example create new user Administrator on your pc and add him in SQL Server login the use it else if you use Workgroup but the SQL Servers not all in the Same pc you will use 3 Windows or 2 create Certification in your SQL Server and I will show it in the next post who to create Mirroring With Login Certification.
8- After this Step Click finish No your database witness is Configured

Now your Configuration is Complete and if you compare between images no 8 and image no 1 you will see the difference you will see now we have Mirroring with operation mode high safety With Automatic failover

NOTE:

In Step no 6 you will See I write the port no is 5023 but when i finish my Steps and arrive to step no 8 then click on ok I reactive this Error :

TITLE: Microsoft SQL Server Management Studio ————

For help, click: on this link

________________________ ADDITIONAL INFORMATION:

An exception occurred while executing a Transact-SQL statement or batch. (Microsoft.SqlServer.ConnectionInfo)

________________________

The ALTER DATABASE command could not be sent to the remote server instance 'TCP://IT-PC:5023'. The database mirroring configuration was not changed. Verify that the server is connected, and try again. (Microsoft SQL Server, Error: 1456)

For help, click: on this link

________________________ BUTTONS:

OK ————————

I don’t know what is error I search more and more on the internet but I don’t found good Solution but when I checked the SQL Server log I see something say { SQL Server cannot listen to the port No 5023 }

So I Reconfigured the mirroring again and Change the port for the Witness Server form 5023 to 5024 it’s Working now very good
How to monitor Database Mirroring:
I will monitor database mirroring from Management Studio and by T-SQL

1- I will Stop mirroring Server to input transaction into Principle Server and See the log what happened in It Go to your database Mirroring in Principle Server >> Write Click >>> tasks >>> Lunch Database mirroring monitor

2- Create Table on Principle Server and insert 10000 Record into New table

```
CREATE TABLE TEST( A INT, B INT)
DECLARE @I INT=0
WHILE @I < 100000
BEGIN
INSERT INTO TEST VALUES(@I,@I)
SET @I=@I+1
END
SELECT COUNT(*) FROM TEST
```
3- Now run the Script and insert the Data then let’s go to Check the monitor to See what happened
4- Then Start the mirroring Server and Check the Monitor again
Check the database mirroring information:

```sql
SELECT M.database_id, D.Name, M.mirroring_state_desc,
M.mirroring_role_desc, M.mirroring_partner_name, M.mirroring_partner_instance,
M.mirroring_witness_name, M.mirroring_witness_state_desc
FROM sys.database_mirroring as M inner join Sys.databases as D
on M.database_id = D.database_id
WHERE D.database_id > 4
```
Mirroring in workshop not in DC (Domain Controller)
Now if I have 3 Servers with three SQL server Instance but this servers not trusted = Not in domain this servers in work group but now I won’t to create mirroring but the last step in Mirroring Configuration need from the Services Account What I will write and with no trusted . So what we can do to make these servers is trusted.

Solution:
We will make link between this SQL Server instance this link not the linked server feature but that’s meaning we will make master key and Certificate on all Servers then Create users in the 3 Servers then give grant Connection to this Users on this Mirroring Endpoint Example

<table>
<thead>
<tr>
<th>Server name</th>
<th>Certification</th>
<th>user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server A (Principle)</td>
<td>CERT_A</td>
<td>User_A</td>
</tr>
<tr>
<td>Server B (Mirror)</td>
<td>CERT_B</td>
<td>User_B</td>
</tr>
<tr>
<td>Server C (Witness)</td>
<td>CERT_C</td>
<td>User_C</td>
</tr>
</tbody>
</table>

- Now I create difference Certificate and user on the servers then I will
- Create Certificate Server B and C on server A
- Create Certificate Server A and C on Server B
- Create Certificate Server A and B on Server C

Also I make these Steps on user then give the 3 user in the Server A and B and C grant Connection on Mirroring Endpoint by this Way I make Bridge between the 3 Servers

1- Step 1 on Principle Server:

```sql
USE MASTER
GO
CREATE MASTER KEY ENCRYPTION BY PASSWORD = 'Admin123'
GO
CREATE CERTIFICATE Principle_cert
WITH SUBJECT = 'Principle certificate'
```
CREATE ENDPOINT End_Mirroring
STATE = STARTED
AS TCP (LISTENER_PORT = 5025, LISTENER_IP=ALL)
FOR DATABASE_MIRRORING
(AUTHENTICATION = CERTIFICATE Principle_cert , ENCRYPTION=REQUIREDALGORITHM RC4 ,
ROLE=ALL)
GO
BACKUP CERTIFICATE Principle_cert
TO FILE = 'C:\certificate\Principle_cert.cer'
GO

2- Step no 2 On Mirror Server:

USE master

GO
CREATE MASTER KEY ENCRYPTION BY PASSWORD = 'Admin123'
GO
CREATE CERTIFICATE Mirror_cert WITH SUBJECT = 'Mirror certificate'
GO
CREATE ENDPOINT End_Mirroring
STATE = STARTED
AS TCP (LISTENER_PORT = 5026, LISTENER_IP=ALL)
FOR DATABASE_MIRRORING
(AUTHENTICATION = CERTIFICATE Mirror_cert , ENCRYPTION = REQUIREDALGORITHM RC4 ,
ROLE=ALL)
GO
BACKUP CERTIFICATE Mirror_cert
TO FILE = 'D:\certificate\Mirror_cert.cer';
GO

3- Step No 3 on Principle Server:
Copy the Certificate“Mirror_cert” From Mirror Server to the Principle Server because I will Create the Certificate Mirroring Server on Principle Server with the User name Mirror_user

USE MASTER
GO
CREATE LOGIN Mirror_login WITH PASSWORD='Admin123'
GO
CREATE USER Mirror_user FOR LOGIN Mirror_login
GO
CREATE CERTIFICATE Mirror_cert
AUTHORIZATION Mirror_cert
FROM FILE='C:\certificate\Mirror_cert.cer' -----the Path of your Certificate After you Copy it
GO
GRANT CONNECT ON ENDPOINT: End mirroring TO [Mirror_login] -----Give privilege to the User Mirror_login to connect to the Mirroring Endpoint” End_Mirroring “
GO

4- Step No 4 on Mirror Server:

Copy the Certificate“Principle_cert ” From Principle Server to the Mirror Server because I will Create the Certificate Principle Server on Mirroring Server With the User name Principle user

USE MASTER
GO
CREATE LOGIN Principle_login WITH PASSWORD='Admin123'
GO
CREATE USER Principle_user FOR LOGIN Principle_login
GO
CREATE CERTIFICATE Principle_cert
AUTHORIZATION Principle_cert
FROM FILE='C:\certificate\Mirror_cert.cer' ---the Path of your Certificate After you Copy it
GO

GRANT CONNECT ON ENDPOINT:: End Mirroring TO [Principle_login] ——-Give privilege to the User Principle_login to Connect to the Mirroring Endpoint” End_Mirroring “

5-  Step No 5 on Witness Server: Create master Key and Certificate Witness_Cert

USE MASTER
GO
CREATE MASTER KEY ENCRYPTION BY PASSWORD='Admin123'
GO
CREATE CERTIFICATE Witness_cert
WITH SUBJECT='Witness certificate'
GO
CREATE ENDPOINT End_Mirroring
STATE=STARTED
AS TCP (LISTENER_PORT= 5027, LISTENER_IP=ALL)
FOR DATABASE_MIRRORING
(AUTHENTICATION=CERTIFICATE Witness_cert,
ENCRYPTION = REQUIRED ALGORITHM RC4 , ROLE = Witness)
GO
BACKUP CERTIFICATE witness_cert
TO FILE='C:\certificate\Witness_cert.cer'
GO

6-  Step No 6 on Principle Server:
Copy the Certificate “Witness_cert ” From Witness Server to the Principle Server because I will Create the Certificate Witness Server on Principle Server With the User name Witness_user

USE MASTER
GO
CREATE LOGIN Witness_login WITH PASSWORD='Admin123'
GO
CREATE USER Witness_user FOR LOGIN Witness_login
GO
CREATE CERTIFICATE Witness_cert
AUTHORIZATION Witness_user FROM FILE='C:\certificate\Witness_cert.cer'
GO
GRANT CONNECT ON ENDPOINT::End_Mirroring TO [Witness_login]
GO

7- Step No 7 on Mirror Server:
Copy the Certificate “Witness_cert” From Witness Server to the Mirror Server because I will Create the Certificate Witness Server on Mirror Server with the User name Witness_user

USE MASTER
GO
CREATE LOGIN Witness_login WITH PASSWORD='Admin123'
GO
CREATE USER Witness_user FOR LOGIN Witness_login
GO
CREATE CERTIFICATE Witness_cert
AUTHORIZATION Witness_user FROM FILE='C:\certificate\Witness_cert.cer'
GO
GRANT CONNECT ON ENDPOINT::End_Mirroring TO [Witness_login]
GO

8- Step No 8 on Witness Server:
Copy the Certificate “Principle_cert” From Principle Server and “Mirror_cert” From the Mirror Server “Principle_cert”

USE MASTER
GO
CREATE LOGIN Principle_login WITH PASSWORD='Admin123'
GO
CREATE USER Principle_user FOR LOGIN Principle_login
GO
CREATE CERTIFICATE Principle_cert
AUTHORIZATION Principle_user
FROM FILE='D:\certificate\Principle_cert.cer'
GO
GRANT CONNECT ON ENDPOINT::End_Mirroring TO [Principle_login]
GO
"Mirror_cert"
CREATE LOGIN Mirror_login WITH PASSWORD='Admin123'
GO
CREATE USER Mirror_user FOR LOGIN Mirror_login
GO
CREATE CERTIFICATE Mirror_cert
AUTHORIZATION Mirror_user
FROM FILE='C:\certificate\Mirror_cert.cer'
GO
GRANT CONNECT ON ENDPOINT::End_Mirroring TO [Mirror_login]
GO

9- take Full backup + Log backup from your Database Mirroring on Principle Server then Go to Mirroring Server and restore this Backup With NORECOVERY Option

10- GO TO the principle Server in make your Easy mirroring configuration but in the last Step don’t write any Service Account let it Empty then After this Step Mirroring will be Complete Successfully

Thanks for all followers

Eng. Mustafa EL-Masry