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As IT environments evolve, it is important to understand the need to implement changes to the ensure continued uptime whilst also providing improvements, bug fixes to the user base. This is where the change management process comes into place.

Your direct supervisor has come to you to get a production software change done to the production Microsoft SQL database server, this change involves updating a stored procedure and adding an index to the respective tables.

This request has come done from key stakeholders in the business as it improves the speed at the data is queried and returned.

Additional Details:

This Microsoft SQL server contains multiple databases that various applications that is used by the business.

This change will only affect one database, however, there is a risk of potential downtime and access restriction to the MS SQL server itself.

You task is to come up with a plan to get this change scheduled into the production environment.

Introduction

In every organization modification is an ongoing process to achieve better performance, addressing the space requirements and improving the latest versions and strategies to maintain and access of the data. After every few years there is a new way to access data from applications, servers and other means. To keep data and accessibility smooth for daily operations such changes are must in every organisation. As per the task assigned by the supervisor to change SQL database production by updating stored procedure and indexing table. To perform any changes on production environment, approvals are must from the HOD and the other stakeholders. Before implying on production environment same can be applied on UAT environment to learn and understanding the challenges faced. This task requires proper planning and publishing timelines for the downtime and the impacts of it. There are multiple benefits and challenges while performing the changes on the MS SQL database server.

In-class Research

Week 1

Pros and cons for updating the stored procedure
"The main advantages of stored procedure are given below:

1. Improved Performance: A compiled version losts the benefits of flexibility of interpreted programs, while the procedure calls are quick and great because stored procedures are compiled and kept in executable form only. Thus, the response is prompt. Nevertheless, most of the code is loaded into memory only once, since it is cached automatically, and takes a small amount of disk space.
2. Increased Productivity: D, Stored procedures also experienced reusability and modularity aiding in encapsulation of business and SQL functionality.
3. Scalability: The fact of the application processing separation on the server makes the stored procedures more scalable.
4. Maintenance — It is much less difficult to maintain a procedure on a server than to originate copies on a number of client computers since they are centrally located.
5. Security: If the data access is limited, the users are only able to modify data with the stored procedures with the rights of the definer.

Disadvantages:

The main disadvantages of stored procedures are given below:

1. Testing: Verification of logic embedded in a stored procedure is actually a very difficult process. Runtime is where any data errors arising from the handling of stored procedures are produced.
2. Debugging: Debugging of stored procedures can be just not possible or very nearly to impossible depending on the database system. Some kinds of relational databases such as SQL Servers contain debug.
3. The saved procedure may not have provision for version control system.
4. Portability: However, in the later versions of the same database level, the complex stored procedures may not necessarily be transported from one site to the other. This is more relevant especially when moving from Oracle to MS SQL server and here you are changing from one database type to the other ." (GeeksforGeeks, 2023)

Week 2

“A schema object that includes keys from different columns of our data table is called an index. The index keys are stored in B-Trees. It speeds up the process of locating the rows or values that need to be searched. They offer several benefits, such as improved efficiency in finding records, organizing records, classifying records, or keeping a distinct column. Increased storage space, slower data change, and clustered index record update are a few drawbacks.

Advantages of Indexing

Querying data

By matching the conditions of the WHERE clause, SQL indexes allows in finding a record or a list of entries. It can assist queries that look for a particular value or within a range of values. Speeding up the search process eventually improves the query's performance. SELECT, UPDATE, and DELETE statements maximize the use of indexes to speed up search performance.

Sorting Records

We sort datasets using indexes. In order to prevent sorting while the query is running, the database locates the index. The keywords ASC and DESC, for ascending and descending, respectively, specify the sorted order. The ORDER BY clause limits the dataset's sorting by specifying one or more fields.

Grouping Records

When the GROUP BY clause is used, the index helps in grouping records with indexed columns. To find the result, SQL queries including the GROUP BY clause sort the columns contained within the clause.

Maintaining a Unique Column

Primary key columns that need unique values are covered by unique indexes. A unique index can be made in a variety of ways. Designating a column as the primary key is one method. A unique index is automatically generated for a main key column. An alternative method is to check the CREATE UNIQUE checkbox, which assigns a distinct index to the columns.
The best way for creating columns with unique values in a database are indexes.

Data is initially searched and compared with all the existing records before being altered by adding or changing rows. It guarantees that the new value won't duplicate already-existing values and will remain distinct. As a result, the index enhances search speed and performance.

Disadvantages of Indexes in SQL

Every component of programming comes with its own set of pros and cons. Indexes are also not an exception. Despite improving the search performances in searching and sorting of records, it has a different set of drawbacks.

Additional Disk Space

Since the clustered index in SQL stores the physical order of the table records in the database, it doesn't require any additional space. The table has a single clustered index since it has a single physical order.
However, for non-clustered indexes that require more disk space, it is different. Separate structures from the table's data rows are non-clustered indexes. Because of the discrepancy between the logical and physical order, it rearranges one or more columns.
When data is stored in a database, it is in the same physical order.

The space is determined by a number of variables utilized in the index, such as the table's size, the number of columns, and the kind of column. When processing a database with many users, storage space is thought to be less expensive than application speed.

Slower Data Modification

The performance of data alteration statements like INSERT, UPDATE, and DELETE is poorly handled by indexes. The database updates itself with the updated index whenever a query requests that the data in the table be changed. As was previously said, indexes facilitate quicker record location, which speeds up sorting and searching. With too many indexes, we may be able to locate the records more quickly, but the speed at which data is modified would suffer. Therefore, we must have a sufficient number of indexes to balance the system's performance.

A Disadvantage to Clustered Indexes

To preserve the sorted order, rows may need to be repositioned whenever a record is updated or the value of an indexed column changes in a clustered index. A DELETE query followed by an INSERT statement, which reduces performance, is another way to think of the UPDATE query. A table's clustered index is automatically generated on a primary or foreign key column. This is so because, like a primary key, a clustered index preserves the table's physical order, which can only be one and distinct.” (Bharti, 2022)

Week 3

“Best Practice of Indexing on SQL Server for improved performance.

1. Understand how database design impacts SQL Server indexes
2. Create indexes for your workload requirements
3. Create indexes for the most heavily and frequently used queries
4. Apply SQL Server index key column best practices
5. Analyze the data distribution of your SQL Server index columns
6. Use data sort order
7. Use foreign keys for your SQL Server index
8. Be mindful of SQL Server index storage considerations
9. Find missing indexes
10. Always create a clustered index before a non-clustered index
11. Monitor index maintenance and update statistics” (Gupta, 2024)

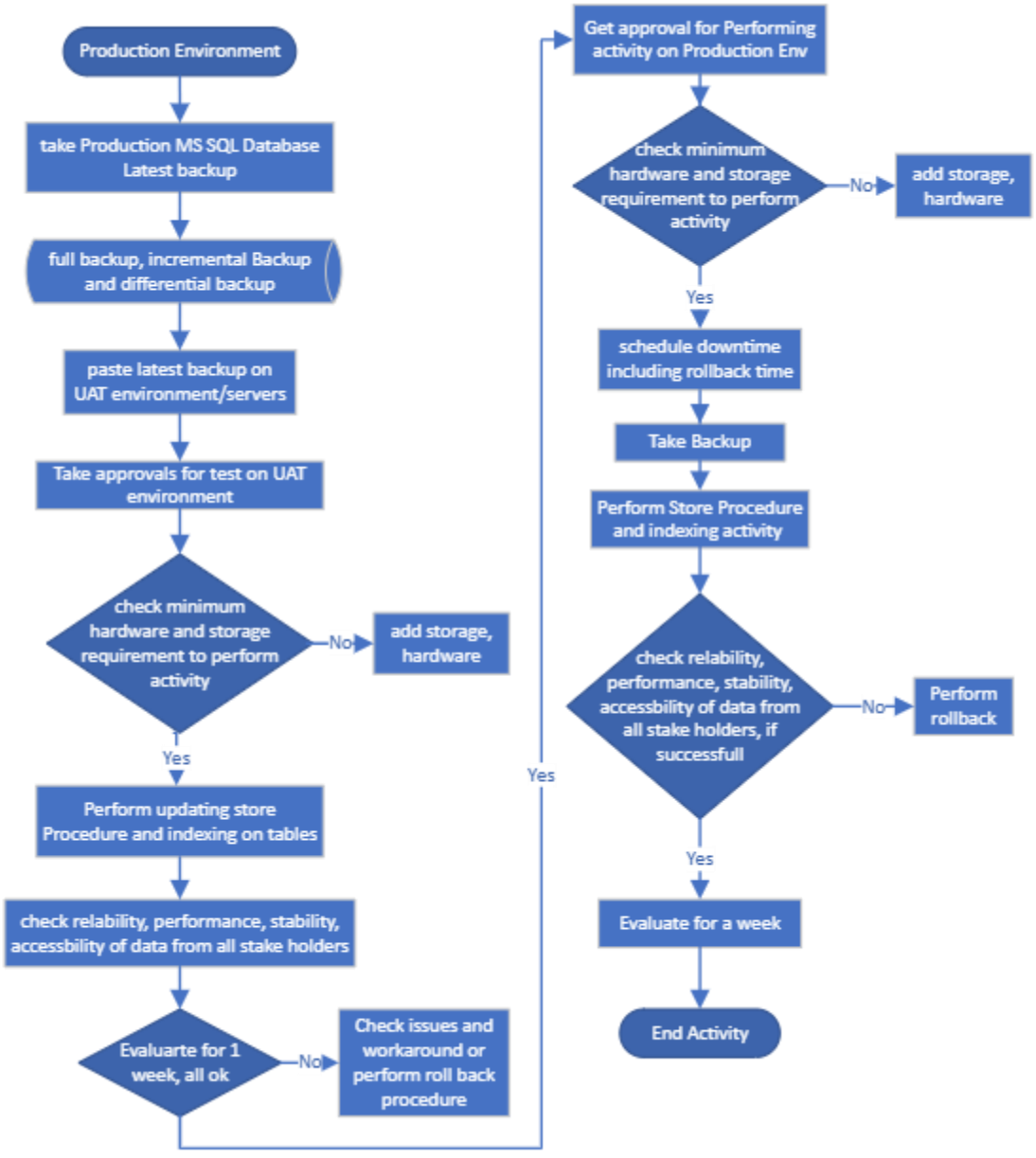
Plan Roadmap

Plan timeline

The changes done on Production SQL Server includes improving stored procedure and indexing on tables. Below are the timelines with planned steps with approximate time required to perform each task. The timeline is approximate time, if all tasks are successfully completed without and issues faced or challenges arises than it can complete before the expected completion timeline.

Agenda	Timelines
Analyzing connections	1 week
Compatibility Check	2 days
Approval for UAT environment	2 days
Adding Storage	1 week
Testing on UAT environment	1 week
Evaluating on UAT environment	1 week
Shifting Connections and Traffic on UAT Environment	3 days
Approval for Production environment	2 days
Downtime with rollback	**2 days**
Upgrading Production environment	1 day
Move connections from UAT to Production Environment	1 day
Monitoring the Production Environment	1 week
Planned Timeline	**1 month, 2 weeks, 6 days**

Flowchart


Production Environment
take Production MS SQL Database Latest backup
full backup, incremental Backup and differential backup
paste latest backup on UAT environment/servers
Take approvals for test on UAT environment
check minimum hardware and storage requirement to perform activity
No
add storage, hardware
Yes
Perform updating store Procedure and indexing on tables
check relability, performance, stability, accessbility of data from all stake holders
Evaluarte for 1 week, all ok
No
Check issues and workaround or perform roll back procedure
Yes
Get approval for Performing activity on Production Env
check minimum hardware and storage requirement to perform activity
No
add storage, hardware
Yes
schedule downtime including rollback time
Take Backup
Perform Store Procedure and indexing activity
check relability, performance, stability, accessbility of data from all stake holders, if successfull
No
Perform rollback
Yes
Evaluate for a week
End Activity

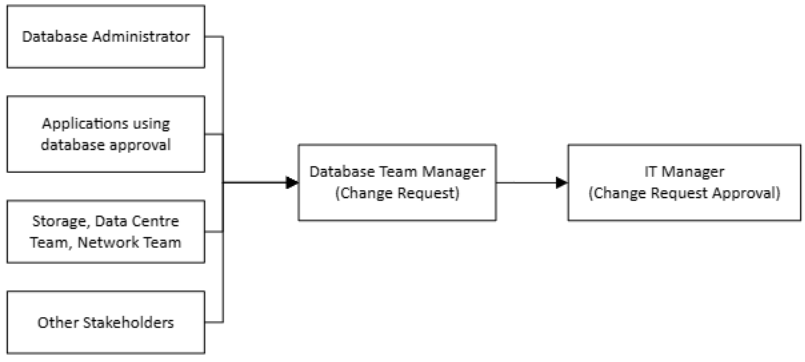
Breakdown of Tasks

Key items to consider in your plan:

1) Will you need to get approvals for this change? What mechanism will you use?

Yes, any changes to the production environment must first have official permission to make the changes. As per the organization's standards a change management procedure has to be followed during the approval process.

- Change Request Form: The process of submitting a change request will involve utilizing the company's change management system, such as raising ticket on Ticketing portal like Remedy, Jira or ServiceNow. The change request will have the history of the activity performed as change in the company's environment. Any possible issue or outrage will all be covered in detail in the request.
- Stakeholders and Managers approvals: Chief Infrastructure Officer, IT managers, database administrators (DBAs), Network Team and security Team and other connected or using stakeholders' approval will be required before performing the change request.
- Risk overview and evaluation: After evaluating the plan of change for the proposed change's request, particularly with relation to possible downtime, the change request will be granted as final clearance. Additionally, stakeholders and managers need to attest that the modification is in line with operational goals.



Making sure that all stakeholders/Teams involved are aware of the possibility of outages and possible limitations on access to the MS SQL Server database and tables is an important part of the approval process. Any impact or issue while

performing the update will be effective for scheduling and communicating with everyone.

2) Is there a need to have this change tested? If so, who will be responsible for this?

Yes, the change must be tested in a UAT environment, to guarantee that the modification is successful and has no unexpected implications, testing is necessary before applying it in the production environment.

The Database Team and the vendor team performing this activity are responsible for any kind of impact in the environment.

• Production Environment: The Production environment will be used to construct and assess the updated stored method and new index. DBAs and developers will ensure that the changes produce the expected performance improvements.

• Testing: After testing, the changes will be implemented and then deployed to a UAT environment that is exactly like the production setup. End users of the company, particularly those who benefit from the performance improvements, and other aspects will confirm the changes.

• Performance Testing: A performance test will be conducted to ensure that query execution times rise as expected and that the changes don't result in any new issues.

Key Milestones

5) What will be your success criteria?

Success criteria can be measured at different levels with different parameters such as:

• Performance increased: The main objective of this changes are to have faster query performance. A measurable percentage decrease in query execution time will serve as the indicator of success (before and after benchmark results will be compared).
• No disconnections to Other Applications/Databases: All applications and databases must support the new changes should not be affected to keep operations running without any problems.
• No Unplanned Downtime: No unplanned downtime or system unavailability should occur during the planned maintenance timeframe when the update is implemented.
• Stakeholders and users' feedback: Verify the database and other connected tables, database are operating as planned and that there have been appreciable performance enhancements.

Plan notification schedule

Pre-Activity:

Notification to the users, applications using the database, tables can be updated via emails, sms or by other means of organization standards as per the communication methods.

This can be considered as first means of communication before performing the changes on the Database or tables, so that users or stake holders can take backups, users or other dependant teams can also raise their questions or challenges before the changes takes place on MS SQL server. The notification includes the timeline of this activity.

Post-Activity:

The managing team or the admin of this activity will publish a notification via email or by an announcement within an organisation to check all the connectivity and stability with the performance of the application and their data to confirm there isn't any issue after activity performed. An improved performance, connections and reliability is also measured to check the achievement of goal to perform this activity.

Delay Notification:

In case of there is any delay or challenges faced while performing this activity, as notification is published via mail to inform that further how much time it will take or what challenges are faced to complete the activity.

Technical Overview

Explaining the software impacts

3) How will you validate that the change will not impact the other databases or the applications that interact with those databases?

Because the server houses several vital systems, it is imperative to make sure that this modification does not impact other databases or programs. There will be a number of validation steps:

• Dependency Analysis: To identify the databases and programs that communicate with the stored procedure and the tables involved, a comprehensive dependency analysis will be carried out. This will guarantee that unforeseen repercussions are taken into consideration.

• Isolated Testing in UAT: The UAT environment will be configured to closely resemble the production environment. Regression tests will be conducted on all databases and applications after the change is delivered in UAT to make sure everything keeps working as it should.

• Monitoring Tools: Before and after the modification, database and application performance will be tracked using tools like SQL Profiler, Dynamic Management Views (DMVs), and Application Performance Monitoring (APM) systems (like SolarWinds and New Relic). In order to identify any unusual activity, alerts will be

triggered.
• Rollback mechanism: A mechanism will be in place to roll back changes in the event of unforeseen problems. A backup of the original stored procedure and table structures will be made, and any modifications can be easily undone.

4) Will an outage need to be declared, if so, how big of a window will be needed?

The declaration of outrage depends on the kind of impact such as minor outrage or major outrage. The outrage window depends on the kind of impact.

There will probably need to be a brief maintenance window because of the possibility of outage and access limitations. The complexity of the change and the testing's outcomes, however, will determine the window's precise duration.
• Estimate: Given the nature of this update, 1-2 hours should be enough downtime time. This covers the time needed for performance validation, production testing, and change implementation.
• Scheduling: To minimize the impact, the outage will be scheduled during off-peak hours. The change will be announced internally (e.g., email alerts, system notifications) and key stakeholders and users will be informed beforehand.

• Backup and Recovery: Before applying the update, complete database backups will be made to guarantee a restoration point in case the modification needs to be undone.

Explanation of the outage window and measuring success.

In every activity there are chances of outrage which can be major impact or minor impact on the infrastructure. The outrage can be measured with specific time and its impact on the systems. It also needs to be addressed with specific workaround time or within downtime duration or if it takes longer time than the downtime then the roll back procedure is performed, and solution needs to be found for the impact caused.

Success can be measured with frequent checks at every task achieved or at regular intervals. Achieving the better performance, low space utilization, quick query results, and so on can be considered as success measuring parameters.

6) What other areas/items should you consider?

• Security Challenges: If the stored method handles sensitive data, the security team should assess the update to make sure it doesn't introduce any vulnerabilities.
• Notification: All users, IT teams, and stakeholders should be informed about the change, anticipated outage, and backup preparations through a thorough communication strategy.
• Observation: The system will be thoroughly watched for at least 24 hours following the change's implementation to make sure there are no problems. Any mistakes or issues faced in performance will be addressed on priority.
• Documentation: All modifications, test findings, and rollback protocols must to be immediately recorded for future use.

Explanation of back-up and recovery requirements

Since each and every part of data is crucial to the organization, it needs to be backed up.

The Backup and recovery requirements are like space requirements on server and storage capabilities based on the frequency of data backups. The data has to be compatible with the new changes to perform the tasks like full backup, incremental backup, scheduled backup and differential backup.

Backup is necessary to assure in case any wrong doings or to make safe side from corruption of data in the database/tables on the SQL Server.

There are options available in MS SQL to schedule automatic and manual backups.

The compatibility of the recovery of data on the MS MSQL server with its version needs to be checked. It may happen that it might get corrupted while recovering the data on server or may not support the data.

The storage requirement needs to be addressed to perform smooth operations like backup and recovery at every instance.

Conclusion

As per planned the changes done on the MS SQL server needs proper test and thorough planned approvals to perform the activity because any kind of issue or impact in the activity can lead to wide challenge to the daily operations of the organization using this database. The proper planned activity to modify the tables and database will help in better performance, less time to query the data. In some areas it will also help in reducing the space and time of utilizing the database and table on the server and in the infrastructure environment. Performing the activity as per the above-mentioned plan will achieve smooth operational activity and close of the activity as per the best practice.

References

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