

Data Migration

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Abstract This document gives the overview of all the process involved in Data Migration. Data Migration is a multi-step process that begins with an analysis of the legacy data and culminates in the loading and reconciliation of data into new applications. With the rapid growth of data, organizations are in constant need of data migration. The document focuses on the importance of data migration and various phases of it. Data migration can be a complex process where testing must be conducted to ensure the quality of the data. Testing scenarios on data migration, risk involved with it are also being discussed in this article. Migration can be very expensive if the best practices are not followed and the hidden costs are not identified at the early stage. The paper outlines the hidden costs and also provides strategies for roll back in case of any adversity.

Keywords Data Migration, Phases, ETL, Testing, Data Migration Risks and Best Practices

1. Introduction

Migration is a process of moving data from one platform/format to another platform/format. It involves migrating data from a legacy system to the new system without impacting active applications and finally redirecting all input/output activity to the new device. In simple words, it is a process of bringing data from various source systems into a single target system. Data migration is a multi-step process that begins with an analysis of legacy data and culminates in the loading and reconciliation of data into the new applications. This process involves scrubbing the legacy data, mapping data from the legacy system to the new system, designing the conversion programs, building and testing the conversion programs conducting the conversion, and reconciling the converted.

2. Need for Data Migration

In today's world, migrations of data for business reasons are becoming common. While the replacement for the old legacy system is the common reason, some other factors also play a significant role in deciding to migrate the data into a new environment. Some of them are

- Databases continue to grow exponentially that requires additional storage capacity
- Companies are switching to high-end servers
- To minimize cost and reduce complexity by migrating to consumable and steady system

- Data needs to be transportable from physical and virtual environments for concepts such as virtualization
- To avail clean and accurate data for consumption

Data migration strategy should be designed in an effective way such that it will enable us to ensure that tomorrow's purchasing decisions fully meet both present and future business and the business returns maximum return on investment.

3. Data Migration Strategy

A well-defined data migration strategy should address the challenges of identifying source data, interacting with continuously changing targets, meeting data quality requirements, creating appropriate project methodologies, and developing general migration expertise.

The key considerations and inputs for defining data migration strategy are given below:

- Strategy to ensure the accuracy and completeness of the migrated data post migration
- Agile principles that let the logical group of data to be migrated iteratively
- Plans to address the source data quality challenges faced currently as well as data quality expectations of the target systems
- Design an integrate migration environment with proper checkpoints, controls and audits in place to allow fallout accounts/errors are identified/reported/resolved and fixed
- Solution to ensure appropriate reconciliation at different checkpoints ensuring the completeness of migration
- Solution to selection of correct tools and technologies to cater for the complex nature of migration

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- Should be able to handle large volume data during migration
- Migration development/testing activities should be separated from legacy and target applications

In brief, the Data Migration strategy will involve the following key steps during end-to-end data migration:

- Identify the Legacy/source data to be migrated
- Identification any specific configuration data required from Legacy applications
- Classify the process of migration whether Manual or Automated
- Profile the legacy data in detail
- Identify data cleansing areas
- Map attributes between Legacy and Target systems
- Identify and map data to be migrated to the historical data store solution (archive)
- Gather and prepare transformation rules
- Conduct Pre Migration Cleansing where applicable.
- Extract the data
- Transform the data along with limited cleansing or standardization.
- Load the data
- Reconcile the data

4. SDLC Phases for Data Migration

The Migration process steps will be achieved through the following SDLC phases.

4.1. Requirement Phase

Requirement phase is the beginning phase of a migration project; requirement phase states that the number and a summarized description of systems from where data will be migrated, what kind of data available in those systems, the overall quality of data, to which system the data should be migrated. Business requirements for the data help determine what data to migrate. These requirements can be derived from agreements, objectives, and scope of the migration. It contains the in scope of the project along with stakeholders. Proper analysis gives a better understanding of scope to begin, and will not be completed until tested against clearly identified project constraints. During this Phase, listed below activities is performed:

- Legacy system understanding to baseline the migration scope
- Migration Acceptance Criteria and sign-off
- Legacy data extraction format discussion and finalization
- Understanding target data structure
- Legacy data analysis & Profiling to find the data gaps and anomalies
- Firming up Migration Deliverables and Ownership

4.2. Design Phase

During design phase i.e. after Analysis phase, High-level

Approach and Low-level design for Migration components are created. Following are the contents of the design phase.

- Approach for end to end Migration
- Master and transactional data handling approach
- Approach for historical data handling
- Approach for data cleansing
- Data Reconciliation and Error handling approach
- Target Load and validation approach
- Cut-over approach
- Software and Hardware requirements for E2E Migration
- Data model changes between Legacy and target. For example – Change in Account structure, Change in Package and Component structure
- Data type changes between Legacy and target
- Missing/Unavailable values for target mandatory columns
- Business Process specific changes or implementing some Business Rules
- Changes in List of Values between Legacy and target
- Target attribute that needs to be derived from more than one columns of Legacy
- Target Specific unique identifier requirement

The detailed design phase comprises of the following key activities:

- Data Profiling - It is a process where data is examined from the available source and collection of statistics and other important information about data. Data profiling improves quality of data, increase the understanding of data and its accessibility to the users and also reduce the length of implementation cycle of projects. Source to Target attribute mapping
- Staging area design
- Technical design
- Audit, Rejection and Error handling

4.3. Development Phase

After completing the Design phase, Migration team works on building Migration components as listed below:

- ETL mappings for Cleansing and Transformation
- Building Fallout Framework
- Building Reconciliation Scripts
- All these components are Unit Tested before Dry Runs.

Actual coding and unit testing will be done in the construction phase. During the development phase, the structures which are similar to target system should be created. Data from different legacy systems will be extracted from a staging area & source data will be consolidated in the staging area. The Construction and Unit Testing (CUT) phase include the development of mappings in ETL tool depend on Source to Target Mapping sheet. Transformation Rules will be applied to required mappings and loaded the data into target structures. Reconciliation programs will also be developed during this phase. Unit test cases (UTC) to be written for validating source systems, source definitions,

target definitions and to check the connection strings, validation of data types and ports, etc.

4.4. Testing Phase

The objectives of the data migration testing are

- All required data elements have been fetched/moved.
- Data has been fetched/moved for specified time periods as per the requirement specification document.
- Data has originated from the correct source tables.
- Verify if the target tables are populated with accurate data.
- Performance of migration programs and custom scripts.
- There has been no data loss during data migration, and even if there is any loss, they are explained properly.
- Data integrity is maintained.

The Migrated data will be tested by reconciliation process. The reconciliation scripts will be developed to check the count between the source system and staging area where the data extracted from the source, to check the count between source staging area, target staging area, and rejection tables. For example:

$$\text{Count of source records} = \text{Count of target records} + \text{count of rejected records in rejection table.}$$

All functional check validations will be verified depends on the business rules through functional scripts. The various ways to do the reconciliation and functional checks, it can be a manual process or automated process. Automation Process includes creating one procedure to check reconciliation which returns the records in the error table if any of the scripts fail and creating one procedure to check the functionality which returns the records in the error table if any of the functionality fails or creating macro to execute the reconciliation and functional scripts in one shot.

4.5. Delivery

The migrated data will be moved to QA environment to

check the quality of data. During this phase, the cutover activities will be performed, and migrations from the legacy systems into Target Systems will be carried out. After the data is loaded, reconciliation of the loaded records will be verified. Reconciliation identifies the count of records which are successfully converted. It identifies those records that failed during the process of conversion and migration. Failed records are analysed to identify the root cause of the failures and they are fixed in order to load them into the target database. The cutover phase includes conversion and testing of data, changeover to the new system, and also user training. This phase is the final phase of the volume move.

In the cutover phase, synchronization of source volume data and the destination volume data takes place. From the project perspective, the final preparation for cutover phase includes:

- Critical issue resolution (and document it in the upgrade script).
- Creation of the cutover plan, based on the results and experiences of the tests.
- Based on the cutover plan, an optional dress rehearsal test can be performed.

Cutover phase requires intense coordination and effort among various teams such as database administrator, system administrator, application owners and project management team. All these team must coordinate the effort closely on every step of the process. Acknowledgement of accomplishment of each step must be communicated to the all the teams so that all are on the same page during the phase.

5. Phases of Data Migration

Following tables describes the different phases of the data migration along with the participating groups and also the deliverables and output associated with each of the phases.

Table 1. Phase 1 - Data Assessment

Key Activities	Key Participating Groups	Deliverables/Outputs
<ul style="list-style-type: none"> • Identification of data sources • Run system extracts and queries • Perform reviews with users on the process data migration • Revise migration scope and validation strategy • Generate work plan with milestone dates 	<ul style="list-style-type: none"> • Data migration leads • End/Business users • Program sponsors 	<ul style="list-style-type: none"> • Scope document • Strategy document • Work breakdown structure with milestone dates

Table 2. Phase 2 - Data Cleansing

Key Activities	Key Participating Groups	Deliverables/Outputs
<ul style="list-style-type: none"> • Analyze and identify if data cleansing is required. • Create worksheets with the steps for data preparation • Clean up of source data • Formatting of unstructured data • Run extracts and queries to determine data quality • Create metrics to capture data volume, peak hours and off-peak hours 	<ul style="list-style-type: none"> • Data migration team • Client Information Support team 	<ul style="list-style-type: none"> • Cleaned/changed source data that increases successful automated conversion data. • Control metrics and dashboards

Table 3. Phase 3 - Test Extract and Load

Key Activities	Key ParticipatingGroups	Deliverables/Outputs
<ul style="list-style-type: none"> • Create/verify data element mappings • Run data extracts from current system(s) • Create tables, write scripts and schedule jobs to automate the extraction • Fix any remaining data clean-up related issues • Execution of application specific customizations • Execution of mock migrations • Using bulk loading functionality, load extracts using tools such as SQL loader • Business rules validation and referential integrity checks through data validation. • Exceptions reporting to client team • Perform data validation 	<ul style="list-style-type: none"> • Data migration team • Client Support team • Data Administrators team 	<ul style="list-style-type: none"> • Source system extraction • Modules, scripts and ETL jobs for data migration • Application populated with transformed data • Various control points to handle errors, exceptions and alerts.

Table 4. Phase 4 - Final Extract and Load

Key Activities	Key ParticipatingGroups	Deliverables/Outputs
<ul style="list-style-type: none"> • Execution of final extracts from the current systems • Execution on target database customizations • Conduct application specific customizations • Deploy pilot migrations • Bulk loading of data extracts using ETL tools into target system. • Perform data validation checks including referential integrity validation and business rules • Acknowledge errors and exceptions to client • Perform data validation 	<ul style="list-style-type: none"> • Data migration • Support team • Data Administrator group 	<ul style="list-style-type: none"> • Extraction of data from source • Data migration modules, ETL jobs and data migration scripts • Control points to identify error and exceptions.

Table 5. Phase 5 - Migration Validation

Key Activities	Key ParticipatingGroups	Deliverables/Outputs
<ul style="list-style-type: none"> • Prepare for migration validation reports and metrics related to data movement. • Review and update migration validation reports and metrics • Verify record counts on the new system • Fix any exceptions or unexpected variations on the data. • Validation sign off 	<ul style="list-style-type: none"> • Data migration team • Client Information Support team • Business users 	<ul style="list-style-type: none"> • Signed-off migration validation document

Table 6. Phase 6 - Post Migration Activities

Key Activities	Key ParticipatingGroups	Deliverables/Outputs
<ul style="list-style-type: none"> • Complete documentation on data migration reports, file and manuals. • Data correctness and quality reports • Target system reports and its accuracy • Infrastructure capacity report and dashboards • Sign off 	<ul style="list-style-type: none"> • Data migration team • Client Information Support team • Business users 	<ul style="list-style-type: none"> • Exception reports, cross-reference files/manuals • Infrastructure dashboards • Signed-off data migration project closure document

6. Approach for Test Runs

Following are some of the best practices followed as test approach for mock runs/test runs to test the data migration activities before the crucial conversion to the production environment. Before entering the mock conversion phase following criteria's must be met

- Tested the developed data conversion, cleansing and data validation programs
- Data Cleansed & transformed the legacy data for mock runs
- Developed & tested target system's load scripts/components
- Target system technical experts, subject matter experts' availability for Mock runs data loads into the target system & verification/validation
- Availability of the target system environment – similar to target production system

Each mock run data load will be followed by validation and sign off by respective stakeholders for confirmation of validation and acceptance.

6.1. Mock Run 1/ Test Run 1

- Cleansed & converted representative legacy sample data (~40%) for mock run
- Execution, reconciliation and load errors reports
- Conversion findings report & validation report for mock run 1
- Data & business SMEs verification & certification

6.2. Mock Run 2 / Test Run 2

- Fixes to the code / revise conversion approach from mock run1 observations
- Cleansed & converted representative legacy sample data loading (~80%) for mock run
- Execution, conversion reconciliation and load error reports
- Conversion findings report & validation report for mock run 2
- SIT will be conducted as part of this test run. Data & business SMEs verification & certification

6.3. Mock Run 3 / Test Run 3

- Fixes to the code / revise conversion approach from mock run two observations
- Cleansed & converted complete legacy data loading for mock run 3 (similar to production run)
- Execution, conversion reconciliation and load error reports
- Conversion findings report & validation report for mock run 3
- UAT will be conducted as part this test run, data & business SMEs verification & certification

Following methods shall be utilized for validation of mock runs

- Visual check of data in the target system based on samples (comparison of legacy data and data loaded in target system)
- Testing of end to end processes with migrated data & system response
- Run target system specific standard reports/Queries for some of the transactional data
- Verification of load reconciliation reports and error reports

7. Migration Approach

Data Migration which is a subset of overall Migration can be achieved either using either Big-Bang approach or Phased Approach. Comparison of Big-Bang vs. Phased Migration is listed below:

Table 7. Migration Approach

Key Activities	Key Participating Groups
No need to run two systems simultaneously reducing complexity and operation overheads	Multiple downtimes and high efforts
In a Big bang migration, it is not necessary to maintain the old environment up to date with record updates. Moreover, the business is driven by the target platform only	Can work out for 24/7 operations scenarios where the system needs to be available and they can nit effort shutdown of the system for data migration.
Single Downtime and Low efforts	No worries of impact on Business during downtime and Cut-over Overrun
Fallback strategies can be challenging particularly if issues are found sometime after the migration event	It can be challenging to execute effectively due to the complexity of the underlying applications, data and business processes
Provides single downtime and low efforts but it adds Risk to the overall Migration due to the volume	Minimizes the Risk of Migration by moving a smaller chunk of Functionality & Data into Target platform but it adds complexity to overall Migration by having two Systems in parallel

8. Common Scenarios of Testing

Below are the common scenarios which we can test during Data migration activities.

8.1. Record Count Check

Data in the staging will be populated from different source systems in general scenarios. One of the important scenarios to be tested after populating data in the staging is Record count check. Record count checks is divided into two sub-scenarios namely

- Record count for Inserted Records: The number of records identified from source system using requirement document should completely match with the target system. i.e., Data populated after running the jobs.
- Record count for updated records: The number of records which are updated in the target tables in the staging using data from source tables must match the record count identified from the source tables using requirement document.

For example, SELCT count(*) from table would give us the number of number of records at the target which is a quick and effective way to validate the record count.

8.2. Target Tables and Columns

If the jobs have to populate the data in a new table, check that required target table exists in the staging. Check that required columns are available in the target table according to the specification document.

8.3. Data Check

Data checking can be further classified as follows.

- **Data validation for updated records:** With the help of requirement specification document, we can identify the records from the source tables where data from these records will be updated in the target table in the staging. Now take one or more updated records from the target table, compare the data available in these records with the records identified from source tables. Check that, for updated records in the target table; transformation has happened according to the requirement specification using source table data.
- **Data validation for inserted records:** With the help of requirement specification document, we can identify the records from the source tables, which will be inserted in the target table available in the staging. Now take one or more inserted records from the target table, compare the data available in these records with the records identified from source tables. Check that, for populating data in the target table transformation is happened according to the specification using source table data.
- **Duplicate records check:** If the specification document specifies that target table should not contain duplicate data, check that after running the required jobs, target table should not contain any duplicate records. To test this, you may need to prepare SQL query using specification document.

For instance, following simple piece of SQL can identify the duplicates in a table

```
SELECT column1, COUNT (column2)
FROM table
GROUP BY column2
HAVING COUNT (column2) > 1
```

- **Checking the Data for specific columns:** If the specification specifies that particular column in the target table should have only specific values or if the column is a date field, then it should have the data for specific data ranges. Check that data available for those columns meeting the requirement.
- **Checking for Distinct values:** Check for distinct values available in the target table for any columns, if the specification document says that a column in the target table should have distinct columns. You can use a SQL query like “SELECT DISTINCT <COLUMN NAME> FROM <TABLE NAME>.”
- **Filter conditions:** When the job is completed, and data is populated in the target table, one of the important scenarios to be tested is identifying the criteria used to retrieve the data from the source table using specification/any other documents. Prepare SQL query using that criterion and execute on the source database. It should give the same data, which is populated in the target table. Filter conditions used to retrieve the data

from source tables must match the criteria identified above.

Let's assume that the source table has both male and female customer information and based on requirement, the target table has been populated with the records having the male customers only. In this scenario, a SQL query can be written with a filter condition to select only the male customers and thereby verify the record counts of the male customers in the target table to the source table.

- **Many source rows to one target rows:** Sometimes requirement specifies that, from many similar records identified from source, only one record has to be transferred to the target staging. For example, If the criteria used to retrieve the records from source tables gives 100 records, i.e., 10 distinct records are there, and each distinct record is having nine similar records, so total is $10 \times 10 = 100$. In such case, some requirement specification enforces that only ten distinct records have to be transferred to a target table in the staging. This condition needs to be verified, and it can be tested by writing SQL statements. In some cases, certain requirements specify that all the records identified from source have to be transferred to the target table instead of 1 distinct record from several similar records, In this case, we have to check the data populated in the target table to verify the above requirements.
- **Check the data format:** Sometimes data populated in the staging should satisfy certain formats according to the requirement. For example, date column of the target table should store data in the format 'YYYYMMDD'. This kind of format transformation has to be tested as mentioned in the requirements.
- **Check for the deleted Records:** In Certain scenarios, records from the source systems, which were already populated in the staging, may be deleted according to the requirements. In this case, corresponding records from the staging should be marked as deleted as per the requirements.

8.4. File Processing

In few scenarios, it is required that data in the staging has to be populated using flat file which is generated from a source system. Following tests are required to conduct before and after executing jobs to process the flat file.

- Check for the directories where the flat file has to be placed for processing.
- Check for the directories where the flat file should be placed after processing is completed.
- Check that file name format is as expected.
- Check for the record count in the target table. It should be as specified in the requirement.

While populating data from flat file to the target table, Data transformation has to be happened based on the requirements.

8.5. File Generation

Sometimes batch jobs will populate the data in a flat file instead of tables in the database. This flat file may be used as input file in other areas. There is a need to verify the correctness of the file generated after running the batch jobs. Following steps need to verify as part of the testing.

- Check that target directory is available to place the flat file generated. This check needs to be conducted before running the job.
- Since the generated flat file will be used as an input file to another system in the integrated environment, check that generated flat file format and file name format meets the requirement.
- Check that data populated in the flat file meets the requirement. Validate the data populated in this file against source data.
- Check that number of records populated in this file meets the specification.

9. Data Migration Risk

Risk management should be a part of every project where various risks must be identified and lay out a plan to resolve them. There are various data migration related risks such as completeness, corruption, stability etc which should be identified and mitigated at the various levels of migration.

9.1. Data Quality

There is high risk associated with the understanding of business rules & logic related to flow of information between the source and target systems. Data from the source system may not map directly to Target system because of its structure, and multiple source databases may have different data models. Also, data in source databases may not have consistent formatting or may not be represented the same way as the target system. There will be lack of expertise in source data formats. Understanding how data has been formatted in the source system is critical for planning how data entities will map to Target.

9.2. Extraction, Transformation, and Load Tool Complexity

Business systems, now a days consist of many modules and have more functionalities. In the past, simple commands were executed and data were directly loaded into the database, but with the evolvement of business systems, the systems become more complex. Hence, ETL have to use APIs which is not a recommended to perform Extraction, transformation, and loading of data.

9.3. Performance of Systems (Extraction and Target System Persistence)

The poor performance of application could lead delay in a load of data, hence through testing with multiple runs and cycles are essential to figuring out the exact performance of

the system. Load test and stress tests need to be carried out to check the feasibility of the application to run on a high volume of data during peak hours. Hence IT managers should ensure that the best performance people are monitoring the load process and can tune the systems properly. From database perspective, it may require to increase the memory allocated or to turn off archiving or altering the indexing.

9.4. Project Coordination

Most data migration projects will be strategic for the organization and will be used to apply the new business system. This involves multiple roles to be played during analysis, design, testing, and implementation. It requires dedication and well-planned coordination to meet the schedule of data migration as any slippages in any of the phase will impact the overall project.

10. Data Migration Challenges and Possible Mitigations

Table 8. Data Migration Challenges and Mitigations

	Potential Challenges	Mitigation areas/accelerators
1	Legacy data fitment and hidden data quality issues	Conduct data quality assessment to understand issues on migration. Leverage any data quality assessment framework
2	Data staging and integration from various sources. Source data is not available in specific formats	Define source-neutral data formats/models to hold legacy data
3	Business rules for data conversion cleansing	Data quality issues must be reviewed and business rules must be defined by the SMEs for Legacy Systems
4	Data Reconciliation	Re-usable re-conciliation and audit framework & design
5	Data validation and manual data enrichment by the data stewards/owners	Information platform web application to view/verify exceptions and take appropriate decisions on the error records by data stewards/owners/subject matter experts
6	Unexpected load failures of the cleansed & converted data at the time mock runs at the target. Also, leading to increase in the number of mock runs/increase in the mock run cycle period	Build pre-target load validation rules within the staging area to identify target load issues in advance
7	Incomplete/Improper data in the target system post loading	Process to automate the post data load verification
8	Unavailability of load error analysis reports	Process to automate and generate error log analysis reports

Data migration activities are no longer a threat to IT organization. IT manager's uses best practices followed in the industry, technology-driven focus, and domain experience to tackle the task of data migration. Data migration process can be divided into the smaller tasks by which the process and procedures are controlled and will help the organization in reducing the cost and time to completion. Below are the few challenges that might pose a risk to the data migration activities.

11. Performances and Best Practices

11.1. Performance

Performance of the migration can be optimized for both staging area and ETL jobs. Some of the best practices followed in the industry are given below.

11.2. General

- Best practices should be followed by ETL tools for better performance must be adopted for jobs development. Each ETL tool has few tips to increase the performance which can be reused with an understanding of the tool's capabilities can aid in this. Parallel processing and pipelining and allow data to be partitioned are few tips that can improve the speed or performance.
- It is important to keep in mind that ETL tools have been designed to deal with large volumes of data. A join in the database query across multiple tables with large volumes embedded inside a source/SQL stage in the tool can prove to be 'expensive' and may take time to return results. Instead, use the stages provided by the ETL tool to split this query and fully utilize the application database as well. In this case, you can use a join stage so that the database merely fetches data from each table leaving the heavy processing to the ETL tool.

11.3. Extract Phase

- Breaking down the jobs into small technical components to enable a maximum number of jobs in parallel.
- Creation of a special table on the legacy system to maintain the list of customers, contracts, accounts, connection objects and meters that have to be migrated. This would have enhanced performance.

11.4. File Generation Stage

- Creation of indexes to optimize the creation of these flat files.

12. Best Practices

Some best practices for an ETL tool and staging database project are as follows:

12.1. ETL Tool

- Parallel Threads in Query
- Degree of Parallelism of flow of data
- Parameterization: Use the Substitution Parameters instead of Global Variables for constants whose values change only with the environment.
- Temporary tables: Temporary tables which are created during the runtime and then act as normal tables will help in converting complex business logic into multiple dataflows and populate template tables, which can be used for lookups and joins.
- Monitor Log
- Collect Statistics

12.2. Database

- Indexes
- Table Space: Use different table spaces for creating tables as per data volumes, which helps in distributed data storage
- Avoid using 'NOT IN.'
- A number of loaders: The number of loaders can be increased while loading data during jobs as it improves loading performance.
- Avoid use of Select *
- Database utilities: Use the built-in utilities to extract table definitions from the staging database.

13. Hidden Cost Involved in Data Migration Activity

There are both apparent and hidden costs associated with data migration. There should be a proper plan for effective migration as all the stakeholders should understand and appreciate the hidden costs involved in migration.

13.1. Planned & Unplanned Downtime

Scheduled & Unscheduled downtime is expensive due to non-availability of applications or data. This will eventually hit the profits of the organizations. We must ensure that both the application and data are available throughout the migration to avoid any costs associated due to downtime. As a mitigation plan, IT managers can plan to migrate minimal disruptive operations.

13.2. Data Quality

The need for data migration is to have good data quality for the application. If the quality of data in target database/data warehouse is not up to the expectations, the purpose of the entire application is not satisfied. Bad data quality can cause an application long before roll-out. If the data fails to pass a base set of validation rules defined in the target application, the data load will fail which will increase the cost of rework and takes more time for go-live activities. Organizations must establish user confidence in the data. To fully trust data, business should have traceability of each

element of data through data profiling, validation, and cleansing processes.

It is recommended to invest on data quality software as this could save lot of time and also remove the bottlenecks for the data analysts team.

13.3. Man Hours

Staff time is more precious, and it is safer to schedule the migration activities during holidays or weekends to have minimal impact on the businesses. This will certainly reduce the downtime needed during critical hours. To reduce the overtime cost, business should look ways to zero downtime migration. There is no guarantee that all the steps will reduce the necessity for overtime, but certainly, it will also better place the IT department to deal with certain problems without the need for disruptive and expensive unscheduled downtime. It also helps IT department to troubleshoot and fix errors by avoiding unscheduled downtime.

13.4. Loss of Data

One of the common problems faced in data migration process is the data loss and the frequency of the data loss. Migration strategies should be formulated to mitigate any risk associated with loss of data. Best mitigation policy is to use full data backup of the source system before migrating to the target system.

13.5. Failure to Validate

Many organizations do not involve in proper data validation of their migrations. They purely trust on the validations done by users instead of the data migrated during migration. This will have a series of effects regarding a delay in the identification of problems and these results in either expensive unscheduled downtime during business hours that can extend up to evenings and weekends. Organizations should research and implement a solution which can offer validation capabilities.

13.6. Under Budgeting

Adequate planning on areas such as man hours, downtime, etc. are required for arriving at the cost of data migration to avoid any surprises on the cost involved in the data migration. Sometimes it will be either over budgeted or under budgeted and according to industry analysts in two thirds of the migrations companies calculate wrong man hours/downtime requirements.

14. Roll Back Strategy

Rollback strategy is mandatory for any data migration process as a mitigation plan to restate the application activities in case of any unforeseen situations or failure during migration activities. This has to be planned between initial pilot phase and throughout the entire phases of actual migration. This has to be planned for every level specified in

the migration planning. This strategy will help in describing all the activities to be executed. If a process fails or does not produce an acceptable result.

On a broader note, we should plan for the following activities

- Plan to clean the target system data when the target is also in a production environment.
- How to push the transactions during the migration / cut-over window into legacy applications?
- Plan to minimize the impact on downstream/upstream applications.
- Restore the operations from existing or legacy systems
- Communication plan to all stakeholders.

15. Reconciliation

Data audit and reconciliation is a critical process which ascertains a successful data migration. Reconciliation is a phase where target data is compared with the source data to make sure that data has been transformed correctly. It is essential in keeping migration on track and also ensure the quality and quantity of the data migrated at each stage. At the extract and upload levels, Validation programs have to be implemented to capture the count of records. Analysis and Reconciliation (A&R) checks for accuracy and completeness of the migrated data and deals with quantity/value criteria (number of objects migrated etc.). A&R does not include verification of the data that has been migrated to make sure that the data supports the business processes. Reconciliation requirements are driven by both the functional teams -Process Owners requirements and the Technical reconciliation requirements. Following are the tasks related to A&R process.

- Run reports at source: A&R reports can be executed at legacy and number of records extracted will be validated against the legacy system. Hash counts for key columns are noted.
- Extract Validation: Data Extracts can then be validated against the Data Acceptance Criteria. This will also include validation of count of records and hash count mentioned in Source A&R reports
- Run intermediate reconciliation in transformation layer: For some objects, intermediate reconciliation can be run at the data transformation layer.
- Run reports at target: Target A&R reports must then be executed to validate the record count and hash counts.

16. Conclusions

Data Migration is the activity of moving data between different storage types, environments, formats, or computer applications. It is needed when an organization change its computer systems or upgrade to newer version of the systems. This solution is usually performed through programs to attain an automated migration. Hence, legacy

data that is stored on out dated formats are evaluated and migrated to newer or more cost-effective & reliable storage Area. Data migration depends on the need of target, data will be transformed from legacy systems and will be loaded into the target. Data migration is a regular activity of IT department in many organizations. It often causes major issues due to various reasons like the staff, downtime of the environment, the poor performance of the application and these will, in turn, affect the budgets. To prevent these types of issues, organizations need a reliable and consistent methodology that allows the organizations to plan, design, migrate and validate the migration. Further, they need to evaluate the need for any migration software/tool that will support their specific migration requirements, including operating systems, storage platforms, and performance. To keep in check all the points, an organization needs robust Planning, Designing, Assessment and proper execution of the Project and its variables.

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