

# The Impact of Data Backup and Recovery in Organizational Development: Oracle 11g Perspectives

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**Abstract** – Organizational database or file is as important as the organization itself. Every successful business depends highly on its internal and external data in order to increase their organizational throughput. Data loss and database failure has crippled many organizations in Nigeria and beyond. The reoccurring nature of data loss in both small and medium industries has become worrisome. The essence of this paper is to bring to limelight the impact of data backup and recovery in organizational development with oracle 11g that ensures 100% availability and safety of data. The paper also illustrated comprehensive knowledge on the necessary techniques/ procedures on how to recover data from system crash, restore backed up files, and prompt recovery of lost files. The practical utilization and implementation of this techniques and procedures was used to demonstrate information flow, security and safety of data. This will increase the productivity, services and performance of organizations in Nigeria and worldwide. Multiple data backups and well configured Oracle Enterprise Manager using RMAN Backups, which offer excellent solution in handling data loss and database failure in an organization, were focus of demonstration.

**Keywords** – Backup, Database, Data Security, Information, Recovery, and Oracle Configuration.

## I. INTRODUCTION

Organization depends highly on its internal and external data for sound decision-making, effective business performance and development both in Nigeria and the world at large. The society has become information superhighway where great deal of information is traded digitally. In the business circle, data is the masterpiece that drives the organizational goal (Nkuma-Udah & Adebajo, 2012). The result of organizing, processing and manipulating data in such way to give a complete meaning to the knowledge of the person receiving is termed as information (Nkuma-Udah & Adebajo, 2012). A copy of data is referred to as backup. A copy of electronic data stored separately from the original files is known as computer backup. Backup and recovery refers to the various ways and procedures involved in protecting your database against data loss and retrieving the data incase if there is any loss/failure.

In general, no computer user feels good when he/she losses important file in a computer system. It is disastrous when a researcher lost his stored research work. A report from Global Backup Survey (2009) indicate that 66% of respondents lost files on their own computer system, one-third of Information Technology (IT) decision-makers confirmed data loss incident at their firm which can lead to bankruptcy (Datamonitor, 2007). Survey shows that small businesses are at more risks where 70% proved that a single

incident of data loss can be considered harmful, hence, over one-half of the respondents have already experienced some data loss (Verio, 2007). Also, hard drive manufacturers reported 1% failure, 2-4% failure rate are more common and under some conditions attain to 13% failure rate (Schroeder & Gibson, 2007). In fact, many organizations have suffered setbacks in today's business achievement and processes. Companies, IT firms, institutions, etc suffers a lot when they loss vital files in a computer system. Managers, database administrator, business owners, IT staff risks their jobs when they encounter data loss. Data loss can be traced as a result of data mismatch and mismanagement, information impediment, concurrent transaction, metadata within database, hackers, natural disasters (fire outbreak, flood, and earthquake), performance degradation, ungranted privilege escalation, viruses, failure such as statement, user process, network, user error, media, and instance failure, all these identified problems are capable of causing organization to lost contracts, stock value, or worse. The knowledge of multiple backup, automatic update and scripting command speaks a better way to manage files, restore and recover data.

## II. VARIOUS BACKUP TECHNIQUES OF ORACLE DATABASE

Backup and recovery as an approach in enhancing organizational database performance applying techniques and strategies methods on the oracle enterprise manager application software, as well as provide the just-in time information in event of data failures. The followings are the techniques of backing up of files or database:

### A. Multiple Backups

Multiple backup conformed to data multiplexing which is supported by Recovery Manager (RMAN). Data multiplexing encompasses the proper mechanism for multiple backup and recovery in an organizational data that mostly operated with oracle database. It is establish that no single committed data is loss in oracle database using multiplexing knowledge. For instance, a file called AniEXAM in directory "C:\wamp\www\Project\Exam" is saved in a PC1. By multiple backup, this same file "AniEXAM" can be resaved severally as a backup in another storage device in another system or server within internal and external. RMAN supported interconnection of device so that once you save in one drive it will automatically save a copy as a backup to other system when properly configure in oracle enterprise manager. This multiple backup can be best illustrated in figure 1:

Some of the identified benefits of multiple backup are enable internal and external device backup, easy storage

and accessibility, data loss in one system doesn't affect data in other system, when system or its component crashes or damages, a copy of data from another system can be use, supports other backup system such as online, offline, RMAN, increases organizational throughputs and requires little skills.

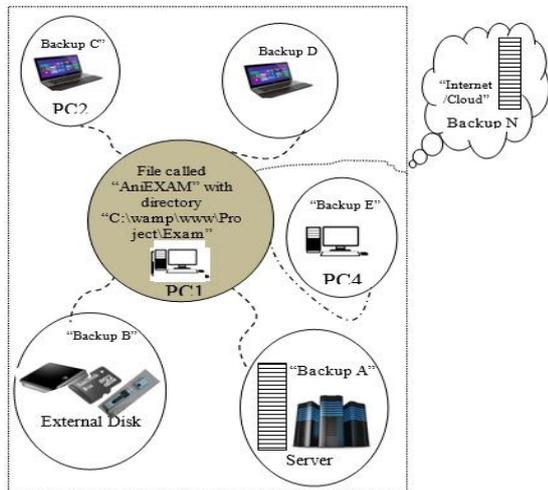


Fig. 1. Multiple Backups Procedure

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### B. Offline Backups

This is process of backing up of data when the database is not open. It is otherwise called "cold" or "consistent" backup. The consistency is based on the time of the backup; the System Change Number (SCN) in data file headers matches the SCN in the control files. Its benefits include the fact that it doesn't require special skills and has low cost of implementation.

### C. Online Backups

This involves online or internet storage and even cloud backup. It could be referred to as "hot" or "inconsistent" backup. It is taken while the database is open. Online backup Synchronizes folder with other computers and generating links for files (Mike, 2013).

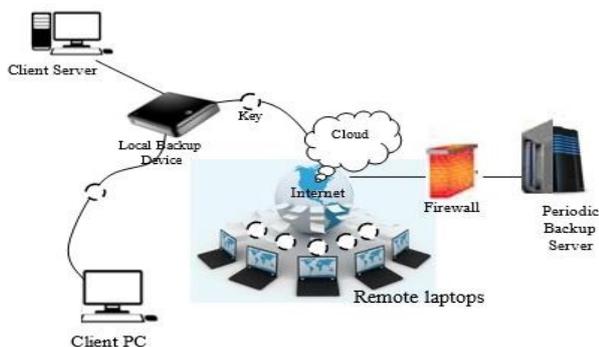


Fig. 2. Online Backups Procedure

Benefits of online backups include it is easily accessible from any device with the help of web, it enables streaming especially files involving video and music, it reduces storage space especially on the cloud, and it supports online redo log and archive.

### D. System Imaging

This contains complete system images taken at one/more specific points in time. It focuses mainly on engaging standard configuration for many systems rather than as a tool for making ongoing backups of different system. Image copies refer to archived log files or data duplicates, just like operating system copying commands. Image copies back up every data block, even if the data block is empty.

#### i. Benefits of System Image Copy Backups:

- Improve granularity of the restore operation.
- Only the file or files need to be retrieved from the tape.
- It is taken in time interval.

### E. Backup sets

This is the collections of one or more binary files that contain one or more data files, control files, archive log files or server parameter files. With backup set, empty data blocks are not stored, thereby uses less space in the disk.

#### i. Benefits of Backup Sets

- Better space usage since it can be further compressed.
- Entire backup set must be retrieved from the tape before the file can be extracted.
- Backup set can be sent directly to the tape or disk.

### F. Whole Database Backups

This involves at least one control file which is identical and all data files. Portion database backup include zero or more table spaces and zero or more data files which may or may not include a control file.

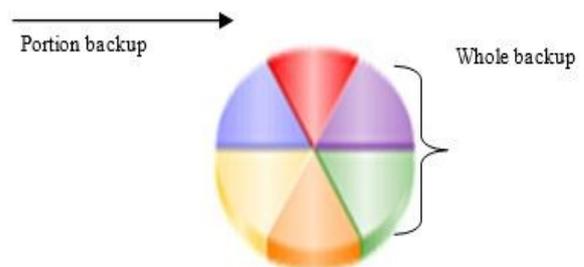


Fig. 3. Whole and Portion Database Backup

Whole database backups do not require you to operate the database in a specific archiving mode. Before performing whole database backups, however, be aware of the implications of backing up in Archive log and No archive log modes (Lance, 2002). A whole database backup is either a consistent and inconsistent backup as observed in the chart below. Whether or not a backup is consistent determines whether you need to apply redo logs after restoring the backup. This can be configured and supported by RMAN backup. The following chart summarizes the whole or entire database backups.

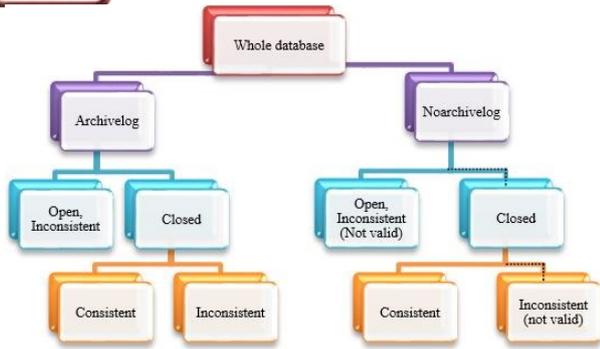


Fig. 4. Whole Database Backups Chart

### G. Incremental Backups

This refers to a copy of all data blocks that have changed since a previous backup. The Oracle database supports two levels of incremental backup (0 & 1). A level 1 incremental backup can be one of two types; cumulative or differential. A cumulative backup backs up all changes since the last level 0 backup. A differential backup backs up all changes since the last incremental backup (which may be in a level 0 or 1 backup). It is supported by RMAN backup.

### H. Secure Backups

This type of backups harmonizes existing functionality by adding backup to tape and network backup capabilities. It covers complete backup solution and media management. Complete backup solution provides data protection for the database and non-database data to protect the entire oracle environment. Media management provides the media management layer for RMAN database backups to tape. Oracle secure backups and RMAN provides an end-to-end backup solution when using oracle environments (Lance, 2002).

#### i. Benefits of Secure Backups in Oracle:

- Enable network backup of any data anywhere.
- Enable centralized tape backup management for file system data.
- Ensures reliable data protection at lower cost and complexity.
- A single technical support resource accelerates problem resolution.

### I. User-Managed Backup

This type of backup is based on scripts which may written by Database Administrator (DBA) or user, though, this method is gradually phasing out because of it high level of intensive labor. For instance, the user may be compel to perform the following statement: querying  $v\$datafile$  to determine the data files that need to be backed up and their current state,  $v\$logfile$  to identify the online redo log files,  $v\$controlfile$  to identify the control file to back up,  $v\$backup$  to see what data files are part of a table space that has been placed in online backup mode and many more scripts, (John and Roopesh, 2010).

#### i. Benefit of User-Managed Backup

- Interactively executed.
- Manually process of tracking backup needs and status.
- Uses your own written scripts.
- Enforces the database files to be put in the correct mode for backup.

- Depends on operating system commands to make backups of files.

### J. Recovery Manager (RMAN) Backups

It makes consistent and inconsistent backups, perform incremental and full backups, and back up either the whole database or a portion of it. RMAN integrated with enterprise manager, backing up of data, server parameter, control and archived log, published Application Programming Interface (API) that interfaces RMAN with many well-known backup software solutions, store backups on the disk/ tape using tape device known as a Media Management Library (MML) for quick recovery for long-term storage.

#### i. Benefit of RMAN Backups

- Supported with oracle enterprise manager.
- Excellent control and scripting language.
- Automatic update of multiple backup disks/tapes.
- Multiplexing enables RMAN to read from multiple files simultaneously and write the data blocks to the same backup piece.
- Integrated with online storage media including online archive log.
- Supported incremental backups, whole database backup, operating system independent language etc.

## III. DEMONSTRATION OF ORACLE 11G BACKUP PROCEDURES WITH RMAN CONCEPTS

In order to use Oracle Enterprise Manager (EM) application software, we consider both relevance to user's contexts, availability, operational and managerial performance to secure, evaluate and protect the confidentiality, integrity and availability of the system. The environment is configured for 100% availability. RMAN ensures the fact "no single committed data is loss in oracle database using multiplexing concepts". There are five (A-E) basic steps in Enterprise Manager RMAN configuration.

For example, configure RMAN backup and recovery using copy of database folder called "AniEXAM" that contain database name "exam" which has seven (7) tables (mst\_admin, mst\_question, mst\_result, mst\_subject, mst\_test, mst\_test and mst\_useranswer) which was created with Hypertext Preprocessor and Structure Query Language (PHP & MySQL), see screen shot in figure 5 below:

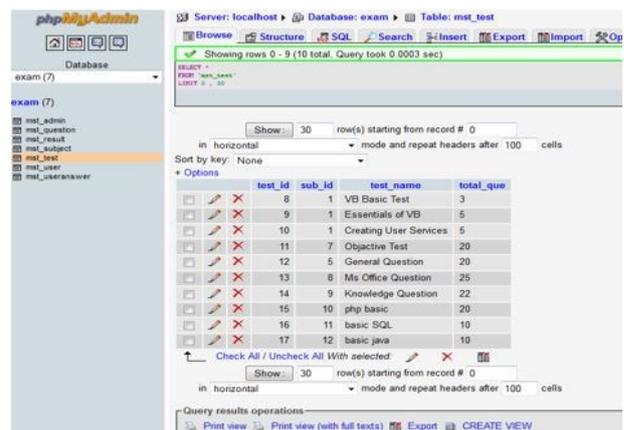


Fig. 5. Copy of School Database Exams

The above database “exam” is created with PHP and MySQL and a copy of the database is configuring with RMAN backup in Oracle Enterprise Manager (EM).



Fig. 6. Enterprise Manager RMAN Backup Settings

The steps of backing up files include:

*a. Backup Settings:*

Select Enterprise Manager > Availability > Backup Settings.

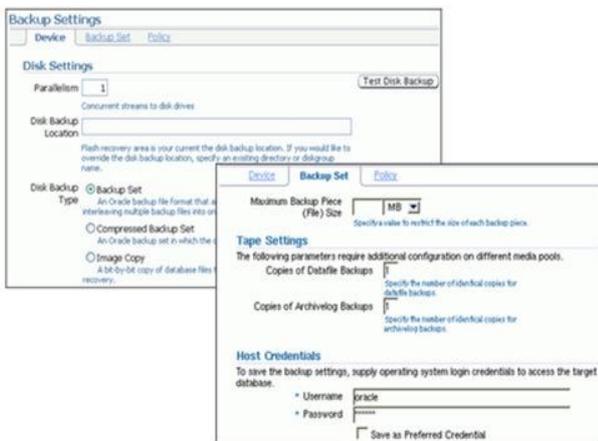


Fig. 7. Backup Settings

Some consideration: (i) Disk backup location: Where should backups be stored? The default is the flash recovery area. If you change this, click Test Disk Backup to verify that RMAN can write to the new location. (ii) Disk backup type: Select Backup Set, Compressed Backup Set, or Image Copy. Click the Backup Set tab to set the maximum file size of backup pieces and to specify redundancy for tape backups. Host credentials are required for Enterprise Manager to save changes to the backup settings.

(iii) Click the Policy tab to: (a) automatically back up the control file and server parameter file (SPFILE) with each backup. (b) Optimize backups by not backing up files that exactly match a file that is already part of the retained backups. This setting enables you to skip read-only and offline data files. (c) Enable blocks change tracking and specify a location for the tracking file. If you have in mind to create incremental backups, this setting can decrease the time required to choose which blocks to include in the incremental backup. (d) Exclude table spaces from a whole database backup. (e) Specify a retention policy: How long should RMAN keep your backups? If you are using the flash recovery area to store backups, RMAN automatically deletes old backups to make room for new ones. By default, only the last backup is retained. The retention policy can be specified as a number of backups or a number of days.

*b. Scheduling Backups: Strategy:*

Select Enterprise Manager > Availability > Schedule Backup. Select either the Oracle-Suggested Backup strategy or your own customized strategy. The Oracle-Suggested Backup strategy makes a one-time whole-database backup, which is performed online. This is a baseline incremental level 0 backup. The automated backup strategy then schedules incremental level 1 backups for each successive day. By clicking Schedule Customized Backup, you gain access to a wider range of configuration options. Select the objects that you want to back up—the whole database (the default) or individual table spaces, data files, archived logs, or any Oracle backups currently residing on the disk. Both strategies enable you to set up encrypted backups.

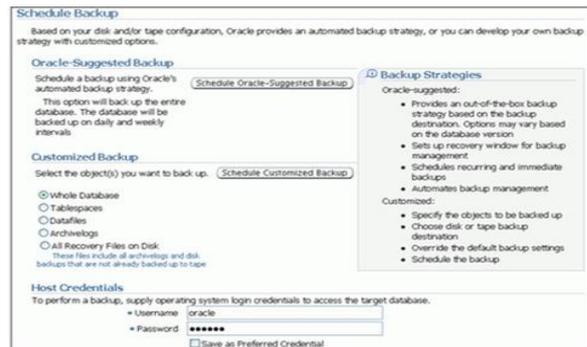


Fig. 8. Schedule backup

*c. Scheduling Backups: the Review*

RMAN uses its own command syntax and scripting language. Using this page, you can customize the RMAN scripts or copy them for recording purposes if required.



Fig. 9. Schedule Customized Backups: Review

*d. Backing up the Control File to a Trace File*

Select Enterprise Manager > Server > Control Files to manage your database’s control files. Control files have an additional backup option; they may be backed up to a trace file. A control file trace backup contains the SQL statement required to re-create the control files in the event that all control files are lost. Multiple copies of the control file placed on separate disks and separate controllers would lose all control files at the same time, it is possible. Therefore, the administrator should back up the control file to a trace file after each change to the physical structure of the database. Trace copies of the control file can be created by Enterprise Manager as well as SQL command as follows:

SQL > ALTER DATABASE BACKUP CONTROLFILE TO TRACE;

The trace backup is created in the location specified by the USER\_DUMP\_DEST initialization parameter (for example, /u01/app/oracle/diag/rdbms/orcl/orcl/trace with a file name such as orcl\_yktm\_8400.trc). More information can be view with the advanced tab of the Control Files.

*e. Viewing Backup Reports*

Select Enterprise Manager > Availability > Backup Reports. The content is based on the control file. The backup report contains summary information as well as detailed information about the input and output of a specific job, including timing, SCN, sizing, compression, corruption, etc.

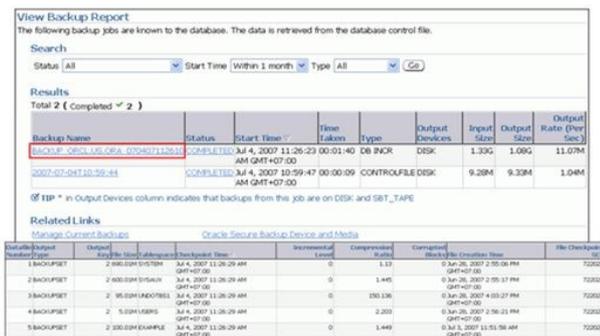


Fig. 10. View Backup Reports

### IV. HOW TO RECOVER A BACKED UP FILE AFTER SYSTEM CRASHES IN ORACLE

*i. User-Managed Restore and Recovery:*

If you do not use RMAN, then use SQL\*Plus RECOVER command to recover the database. For instance, assume that Joseph Igwe lost the /oracle/dbs/user3.dbf data file, which is contained in the user’s table space, to a media (CD/HDD/Optical, magnetic tape etc.) failure. Again, let’s assume that Joseph Igwe have a backup called /dsk2/backup/user1.dbf on a separate disk drive. You discover that the data file is missing because a query returns an error saying that the file is missing.

Do the following:

- (a) Take the users table space offline. For example, Igwe run this:

```
SQL> ALTER TABLESPACE users OFFLINE IMMEDIATE;
```

To restore the backup of users3.dbf using an operating system utility. For instance, you run UNIX command: % cp /dsk2/backup/users3.dbf /oracle/dbs/users3.dbf. Assuming that you have all necessary archived redo logs, you can recover the data file with SQL\*Plus command: SQL> RECOVER AUTOMATIC DATAFILE /oracle/dbs/users3.dbf;

- (b) Bring the table space online: SQL> ALTER TABLESPACE users ONLINE;

*ii. RMAN and User-Managed Restore and Recovery:*

There are two steps for recovering physical files:

- (a) Use the RMAN utility to restore and recover the database, and
- (b) Restore backups by means of operating system utilities, and then recover by executing the SQL\*Plus RECOVER command. Before performing media

recovery, you need to determine which datafiles to recover.

You can use the fixed view V\$RECOVER\_FILE to lists all files that require recovery and explains the error that necessitates recovery.

*iii. RMAN Restore and Recovery:*

The basic RMAN recovery commands are RESTORE and RECOVER. Use RESTORE to restore data files from backup sets or from image copies on disk, either to their current location or to a new location. You can also restore backup sets containing archived redo logs. Use the RMAN RECOVER command to perform media recovery and apply archived logs or incremental backups. RMAN automates the procedure for recovering and restoring your backups and copies. For instance, run the following scripts within RMAN to restore and recover the database to its current time:

- (a) SHUTDOWN IMMEDIATE; # shuts down database.
- (b) STARTUP MOUNT; # starts and mounts database.
- (c) RESTORE DATABASE; # restores all datafiles.
- (d) RECOVER DATABASE; # recovers database using all available redo.
- (e) ALTER DATABASE OPEN; # reopens the database.

*iv. Instance and Crash Recovery:*

This is used to recover from a failure either when single instance database or all instances of an Oracle Real Application Clusters (RAC) database crashes. Then do the following:

- (a) At first database open after the crash of a single instance database or all instances of an Oracle RAC database.
- (b) When some but all instances of an Oracle RAC configuration fail. The recovery is performed automatically by a surviving instance in the configuration.

In general, Oracle applies the redo automatically in case of crash and instance recovery; no user intervention is required to supply redo logs.

*v. Redo Application in Event of Recovery:*

This redo data to the datafiles, any time a change is made to a datafile, the change is 1<sup>st</sup> recorded in the online redo logs. Media recovery selectively applies the changes recorded in the online and archived redo logs to the restored datafile to roll it forward. Rolling forward is the first step of recovery from disk/instance failure and reapplying all of the changes recorded in the redo log to the datafiles. Rolling back applies the process of undo blocks to roll back uncommitted changes in data blocks that were either written before the crash or introduced by redo application during cache recovery.

### V. CONCLUSION

The impact of data backup and recovery in organization development with oracle perspective enables an organization to have a full knowledge of various techniques and procedures to protect database from data loss since data loss has become inevitable in small and medium scale industry. Among the various techniques mentioned; multiple data backup in conjunction with RMAN backups

offers excellent practice in maintaining 100% data backup and recovery implementation through multiplexing concepts. Configuring RMAN with oracle EM was fully demonstrated. Restoring and recovery a backed up file and how to recover files in event of system crashes or failure was also covered where RMAN restore and recovery was considered as the best option. In operation, full data backup and recovery leads to information optimization, growth, enhancement of business transaction, favourable product, services, reliable and steady fastness of data processing in day-to-day routines.

## REFERENCES

- [1] A. Lance, "Oracle9i Backup and Recovery Concepts", 2012, Release 2 (9.2) Part No. A96519-01.
- [2] B. Schroeder, and G. Gibson, "Disk Failures in the Real World: What Does an MTTf of 1,000,000 Hours Mean to You?," *In FAST'07: 5th USENIX Conference on File and Storage Technologies, San Jose, CA, 2007*, Feb. 14-16, pdf.
- [3] Data monitor, (2007). McAfee Expands Data Loss Prevention Solution, [Online]. Available: <http://www.mcafee.com/>.
- [4] Global Backup Survey, (2009). About Backup Habits, Risk Factors, Worries and Data Loss of Home PCs, [Online]. Available: <http://www.kabooza.com/globalsurvey.html>.
- [5] K.I. Nkuma-Udah, and A. Adebajo, *Advanced Information Storage and Retrieval*. Victoria Island, Lagos: National Open University of Nigeria Publishers, 2012, pp. 1
- [5] Verio, 2007. Verio Survey Reveals Small Business Data Left Vulnerable to Loss, [Online]. Available: <http://www.verio.com/about/newsroom/pr/index.cfm?>
- [6] W. John, and R. Roopesh, *OCA / OCP Oracle Database 11g, All-in-One, Exam Guide*. New York: McGraw-Hill Companies, 2010, pp. 586-682, Inc.pdf
- [7] W. Mike, (2013). Best Cloud Backup: 10 Online Backup Services Tested, [Online]. <http://www.techradar.com/news/internet/cloud-services/best-cloud-backup-10-online-backup-services-tested-1176843>

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