Transaction Log / Archive Log Volume

– An "Awareness Paper" for Application Support / Application Operations, Operations Managers and Change Managers

Yes, you are reading right – this paper is not for Database Administrators (DBA's)
– The DBA just can explain you more details about that, but he can't prevent outages caused by Operations flooding the database with an untested and unmanageable amount of transaction log. Therefore you need to understand when this could happen and how you can avoid related issues, usually ending in an unplanned outage.

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Summary

Today in most cases restoring a database backup from last night and loosing all online-transactions since time of last backup isn't acceptable at all.

For this reason all professional database systems record changes additionally outside of the database in transaction log files, allowing to "roll forward" all changes since last backup and recovering even the last committed transaction.

But this feature causes some side effects, which – if not understood by staff running the application this feature can cause serious problems and even unplanned outages which can't be prevented by an High Availability (HA) Cluster.

The purpose of this document is to raise awareness to Application Operations and Application Support that this <u>necessary</u> database feature can cause unplanned outages if if not understood and watched out during non-regular operations.

Examples:

- just revoking and re-running a large batch job (or running it for volume of 3 day's data as it failed during last 2 nights)

- running several batches at same time

- data migrations[1]

- jobs during upgrades

- tuning batch runs or adding CPU's resulting in higher transaction log volume per minute

can cause the database to hang – resulting in an unplanned outage.

Note:

- <u>In most cases you can't blame the DBA,</u> as the operations team just "flooded" the database with untested and not in SLA agreed transaction log volume[2]!

- Even your High-Availability (HA) Cluster can't prevent that outage! - If that filesystem is full, a fail-over to the 2nd node wouldn't help (and cluster software knows this situation and doesn't even try to initiate the fail-over, as it makes no sense).

- Monitoring and emergency-increase of the file system size are not always possible – at file growth of 1 GB/minute (60 GB/hour)

For larger database systems with high transaction volume it is absolutely necessary (minimum practice)

- to measure during volume-, load- and stress testing the transaction log volume during different load scenarios – even a medium sized work group server with 8 CPU's can already create easily 1 GB/minute transaction log volume!

- to use those numbers

  - for sizing the number of backup channels dedicated to backup the transaction log (archive log) files

  - for sizing the filesystems storing transaction log files (considering reserve time in case of delayed backup)

  - document those numbers in the capacity baseline

  - communicate and explain those numbers and resulting operational limitations to those staff members starting, revoking and re-running jobs on that or interfacing applications.
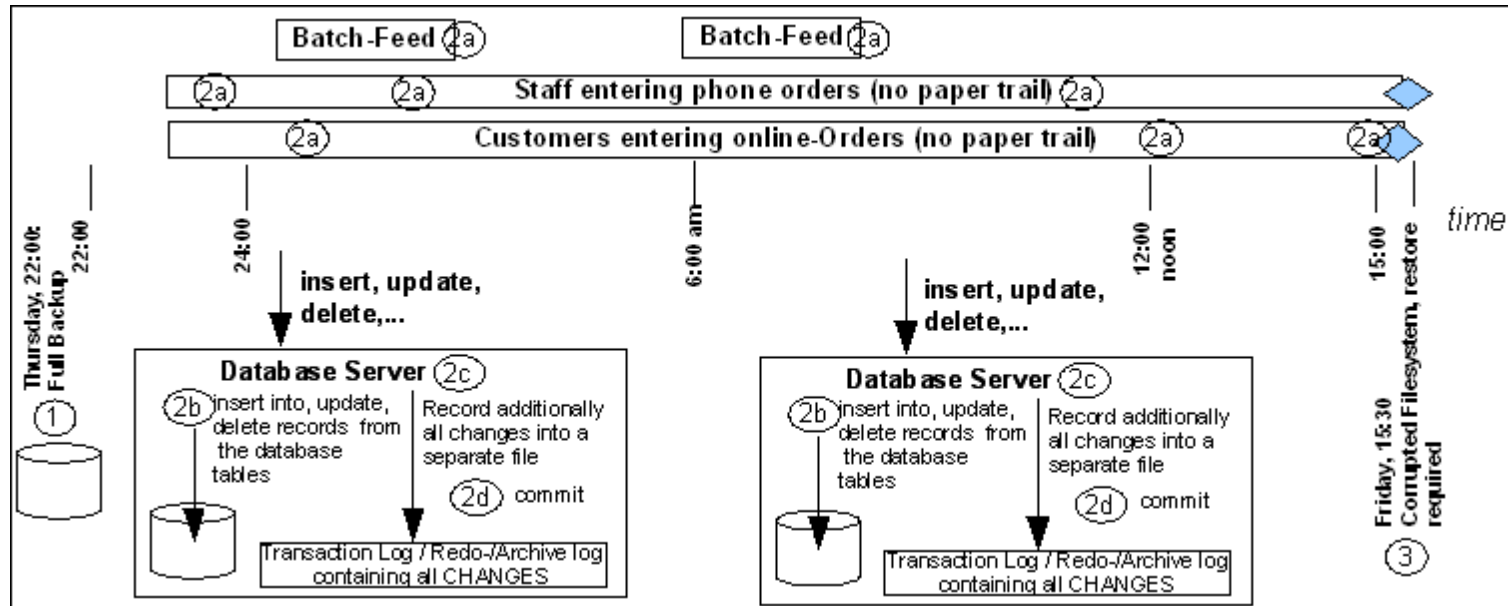
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1   This topic is emphasized in our "Checklist for Data Migration" [3]
2   Our templates for Database and Backup SLA / OLA [1], [2] highlight this topic.

Background

The Purpose and Principle of Transaction / Archive log files

1) Full database backup on Thursday, 22:00.

2a) Data are entered into databases online by customers or by staff based on telephone orders- no "paper-trail" for re-entering is available.

2b) Data entered by users or batch feeds are sent (using SQL commands) to the database server, which updates the database tables ...

2c) and records the changes (old and new values) into a separated file...

2d) and commits only after 2b) and 2c) have been finished.

3) The database backup contains the data from last night, a simple restore would result in loosing all data entered since last backup.

This issue is addressed by the feature "transaction log" or "archive log" mode provided by all professional database systems, and usually (minimum practice) activated during installation.

This feature allows after restore of database backup from last night (1) to "roll forward" all changes since last backup by applying all changes kept in those "transaction log files" (archive log files), as those changes are kept outside of the database in separated files. And as those files are of highest importance, they are

- often stored on two or even more separated filesystems,
- backed up to tape (sometimes to even two different tape sets) hourly or more frequently
- sent off-site within short intervals.

If nothing goes wrong during restore and roll-forward[3], then you will recover the last committed transaction!

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3 Not only database restore, but also the roll-forward should be on the regular testing calendar. Best you have that agreed in the Backup- and Database OLA's [1],[2]

What to measure during volume testing

The following data are very important part of the capacity- and performance baseline document!

Results➡ Activity ⬇	[A] - Gigabytes per work unit	[B] Average work units per Batch	[C] Average Duration	[D] Megabytes/second Gigabytes/Hour at processing speed of [Work-Units/second] or [Work-Units/hour]	[E] Total Gigabytes for (current) 1 day volume peak-days and average days
Normal transaction processing without batch processing					
Hourly loading of data from <feed-system>					
Hourly extraction batch for system <xxx>					
Daily "end of day" processing					
Nightly archiving and purging					
Monthly journals					
Total	N/A	N/A	N/A	Peak value of when running following batches concurrently	The average and peak daily volume will be of course less then 24x hourly peak volume.

[A] The "Gigabytes per work unit" is a useful input number for capacity planning, as "number of customers", "number of transactions per day" are provided by business.

[D] This number will increase if due to tuning or server upgrade the average duration [C] decreases – or a higher number of work units [B] is processed in same time.

What Application Operations needs to understand:

Each INSERT inserts records into the database tables, each UPDATE changes records in database tables, each DELETE removes records from the database tables.

But additionally for each of those actions the "difference-information" is written to files outside of the database.

Impact: Even if your average deletes (oldest transactions) makes enough space for new inserts and the size of database tables (which you might be watching carefully) is constant, your daily processing creates additional files which you might not even know about. And since years you did not have any problems with those files.

But in special situations, e.g. your archiving / deleting of old transactions was stopped for 2 months and now you try to catch up during one night, those transaction log files will record 2 months of "delete transactions" – and that might cause the file system to run full.

Bottom Line:

Whenever you plan to run something which you don't do in regular operations and which processes a larger amount of data you should question the transaction log volume.

Just because you got more CPU's does not mean that you can now re-start all jobs failed during last night just at 9 am after arriving in the office.

What Change Managers should ask:

1. Does the change require large volume database transactions?

2. If yes, how much transaction log volume will be created, is there sufficient space and backup capacity for managing this additional volume.

3. How close to production system was the test system used? (See chapter "The Testing-Trap: We tested that – and the problem did not happen on the test system")

4. In case that a standby database in a remote data centre for DR-protection exists: Is the capacity on the network to the remote data centre sufficient to cope with the additional transaction log volume?

In case that e.g. during a huge data migration the archive log volume is that huge that it can't be managed, the option to disable this mode during the data migration or upgrade is possible but requires

• that NO other data processing except this migration or upgrade takes place (full planned system outage)

• additional time for a complete cold (offline) backup before and after this activity – that can be a few hours

• additional time for complete application- and database shut-down and re-start to change the transaction log mode of the database server.

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Real Production Incidents

Example 1 – updating a huge table during Software Upgrade

Business wanted to know exact duration of downtime during next software upgrade.

The development consultant knows that populating a new database column added to the largest table might run long and recommended to run that SQL on existing production system and roll back the command afterwards.

something like:

```
update <very_big_table> set <new_column> = ...;
rollback;
```

Some time later the DBA team got an alarm from monitoring system that the filesystem storing the transaction logs (archive logs) is running full.

The reason – abnormal huge transaction log volume caused by an UPDATE on a huge table – was quickly identified.

The DBA team immediately informed the department running the application, but just got the answer: "It's Friday afternoon – the person who started that already left for the weekend".

The DBA team did the best possible – activate more backup channels for this file system, but the backup system couldn't cope with that never seen volume before.

After midnight the file system finally run full, application crashed and the cluster monitor initiated a fail over ..

How to avoid:

Test all unusual actions on a fully-sized production copy.

Measure the transaction log volume during this time – but make sure that you don't run into one of the "testing traps" listed on next page!

Note: Your test database might not have the transaction log mode enabled! - Dependent on database software used, the DBA will / might be able to measure that volume which would be generated in transaction log mode. In case of Oracle ® database server he just needs to count the log switches and multiply with the size of the redo log files.

Example 2: Sudden breakdown of WAN – performance to remote DR Data Centre

Situation:

Batch processing was running as usually and creating a significant amount of transaction log per hour, but not more than usual.

Due to performance breakdown on the WAN performance to the remote data centre archive log files could not be transmitted fast enough.

As result the database got hanging on DML actions (insert, update, delete) for about 15 minutes, working for 5 minutes after one file more has been transferred and stuck again for 15 minutes. This situation lasted for a few hours (during night) until the WAN-problem was solved.

How to avoid:

- • Ensure guaranteed "Quality of Service" for transfer of transaction log / archive log files through WAN-connection to remote data centre (such that not other activities on the WAN slow down this important operation).
- • Study all possible configuration options for the product you are using to transfer those transaction logs / archive logs.
- • Enable this database operations mode only after a written management statement for this situation was provided:
    - • it is accepted that the database will not be available but this important protection may never be turned off.
    - • or that it is accepted that the DR protection will be disabled for this time – and the re-establishment of this protection will take <x> days.

When this situation happens no high manager will be available for a decision, and the DBA's decision will be always blamed to be wrong afterwards.

This is only one of the topics of the document [3] specialized on DR.

The Testing-Trap: We tested that – and the problem did not happen on the test system

Production System	Test System	Impact	Mitigation
Full data volume	**less data**	jobs process less volume and therefore less archive log	Measure transaction log volume per e.g. 1,000,000 customers or 1,000,000 orders and extrapolate.
transaction log mode	**not in transaction log mode**	transaction logs overwritten after short time, therefore no large amount of files created.	Measure and estimate how much transaction log would be produced in case that database runs in transaction log (archive log) mode.
transaction log mode **triggers / snapshot logs for capturing changes (typically for replication to DWH)**	transaction log mode	The triggers on database tables recording which records have been changed create additional inserts into special tables (e.g. MLOG$_xxx) used by DWH refresh – and therefore more transaction log volume. Especially during / after the DWH refresh, when those records are deleted again additional transaction log volume is created! - And much faster than during normal daytime!	
log file shipping to remote database (standby database) in remote data centre for DR purpose	**no log file shipping**	old transaction log files are deleted • after they have been backed up to one or even two different backup devices (often tapes) • and after they have been transferred to the remote standby database. If the transfer to the remote data centre is slow because of capacity problems on the Wide Area Network (WAN), then the old transaction log files are not deleted fast enough to make space for new transaction log files. [3]	Measure and document the required transfer rate and get this rate guaranteed by network team. Otherwise high level managers need to agree to decision to turn off DR protection during the special processing creating unusual transaction log volume. **Warning:** Don't "test" the possible transfer volume without detailed coordination with network team – Your "test" might cause that much traffic on the WAN that other applications will slow down or even fail! **One more testing trap:** If your application uses the command "create table as select .... nologging" or "create index ... nologging" then this activity will not create transaction log on the test database, but this "nologging option" will be ignored on the production database as those information needs to be replicated to the standby database!

Appendix

References

[1]	**Operations Level Agreement (OLA) for Big and Large Databases -** Mercury Consulting Ltd., Schaan, 2005 http://www.it-checklists.com/template_database_SLA_operations_level_agreement_OLA.html
[2]	**Operations Level Agreement (OLA) for Backup and Recovery -** Mercury Consulting Ltd., Schaan, March 2006 http://www.it-checklists.com/Template_backup_SLA_Operations_Level_Agreement_OLA.html
[3]	**Decision Template for Selection of Disaster Recovery (DR) Technology -** Mercury Consulting Ltd., Schaan, May 2006 http://www.it-checklists.com/Decision_Template_Technology_Selection_for_Disaster_Recovery.html
[4]	**Checklist for Data Migration -** Mercury Consulting Ltd., Schaan, 2005 http://www.it-checklists.com/checklist_data_migration.html
[5]	**Application Upgrade / Migration Checklist -** Mercury Consulting Ltd., Schaan, 2007 http://www.it-checklists.com/Application_Upgrade_Checklist.html

Acronyms

DBA	Database Administrator
DWH	Data Warehouse
WAN	Wide Area Network

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Database Independent Products

Product	Benefit
270 Non functional Requirements.	Requirements Template with 70 non functional requirements for selecting or developing robust, reliable, stable and manageable applications to meet the Service Level Agreements (SLA's). For external RFP's (Request for Proposal) and for internal development.
Checklist for Data Migration	65 important questions to identify and address or exclude typical migration pitfalls in an early phase of the project, thus ensuring the confidence for keeping the time plan.
Template: Systems- and Operations Handbook	Template to establish that documentation auditors like to see for each IT Application / IT-System.
Template "Data Centre Operations Manual"	Template to create an Operations Manual for a Data Centre, focusing on Data Centre Infrastructure.
Application & Server Inventory Template	This document assists in first step of gathering and classifying information about servers, applications and software.
Interface Checklist	Those questions which you need to ask before starting the development! Requirements, Checklist and Template for Planning, Defining and Documenting Application Interfaces.
Server Upgrade / Migration Checklist	This vendor- and operating system independent checklist deals with "big picture" and helps to evaluate all potential impact of upgrading a server, e.g. adding CPU's, replacing CPU's with faster CPU's , Operating System Upgrade, adding Storage or replacing a server with a newer, bigger model
Application Upgrade / Migration Checklist	Purpose of this document is to support • The decision making process of "should we upgrade now or later – or not at all?" • The impact analysis – identification of all internal and external dependencies. • The gathering of requirements for the upgrade. • The selection of the best upgrade approach ("In-Place Upgrade" or "New Installation"). • Providing input required for the Upgrade Planning.
Checklist for Production	Checklist for small and medium projects focusing on non-functional aspects for operations team.

Product	Benefit
Release and System Handover	Simple but effective!
Template for Outage Planning	This template with in-depth explanations of tasks required to plan outages on medium to large IT Systems will avoid that important steps are forgotten.
Application Retirement – Template and Checklist	Very often "Application Retirement" discusses the process of upgrading an application to a newer version or replacing by another similar product, emphasizing the benefits of upgrading and only minor focus on the decommissioning. This document deals solely with the "end of operations" / "decommissioning" of an obsolete IT application or old version of an upgraded / replaced application and addresses IT Organizations at maturity levels between 1 and 3, with highest benefit for those on level 2 striving to achieve level 3.
Backup SLA / OLA	Operations Level Agreement (OLA) with the Backup Team.
Decision Template for selecting Disaster Recovery (DR) Technology	This template helps you to define your individual DR-requirements and after explaining the four main technology groups to select the most suitable technology.
Business Requirements for Archiving and Purging	Template with Business Requirements for Archiving & Restore & Purging. Not removing old customer data can cause conflicts with privacy laws. **Business must act** and clearly specify what to purge and what to archive!
Application Health Check: Stability Assessment	Using this template to check your systems - and DOCUMENT the findings might show you even more potential issues beyond invalid objects.

Database Specific Products

Product	Benefit
Database SLA / OLA Template for Database Operations Level Agreement (OLA) / SLA	If a Service Level Manager needs to offer to Business a Service Level Agreement (SLA) for an End-to-End IS/IT-Service, he sign this SLA only after he arranged within IS/IT for each system or component used to provide this service an **Operations Level Agreement (OLA)** with the providing team or department. This document provides a template for such an Operations Level Agreement (OLA) for Oracle Databases containing the agreed values and for QA-purpose also the measures implemented to reduce the likelihood of violations of those agreed values. It does not only deal with availability, but contains also comprehensive service catalogue of advanced DBA services and a template for the Service Level Reporting (SLR).
Database Health Check - Part 1: Stability Assessment	Stability Assessment of your Oracle Database. Most Application- and Database-Crashes can be avoided when detecting early indicators and reacting to them. **Be Proactive - Check Now!**
DBA and Application Support: Job Description and Self Assessment	Checklist to ensure that all 60 DBA-duties are assigned: System DBA, Development DBA and Application DBA versus Application Support If you have just a job role "DBA", but not a dedicated job role "Application DBA" those 19 duties must be explicitly assigned to either "Application Support" or to the "DBA" - otherwise they might not be executed! **Detect unassigned tasks before an auditor reports them !** This product addresses disputes between System DBA and Application Support (or, if existing, dedicated Application DBA) regarding the responsibility for the application's database objects.

Our free Whitepapers

Whitepaper	Benefit and Description
The Importance of Application Level Monitoring.	Keeping your applications free from invalid objects is an important task, but does not guarantee error free operations. This free whitepaper explains the difference between "Application Level Monitoring" to "Database Monitoring" and "System/Server/OS"-Monitoring.
Important Facts about Redolog- and Archivelog in Oracle Databases for Change Managers and Application Support Staff	Understanding the topic "archivelog volume" can avoid unexpected troubles when applying changes or conducting upgrades. This awareness paper explains why Change Managers must ask questions about the archivelog volume created during changes and upgrades and why application support staff – and not only the DBA - must understand this topic.
The Danger of Invalid Database Objects	An awareness paper for Operations Managers and Application Support describing the problems and potential risks caused by invalid objects in an Oracle Database.
Private or Public Synonyms – or no Synonyms at all ?	A decision support paper visualizing the pro's and contras on a single page in tabular form and evaluating the arguments.
Transaction Log / Archive Log Volume	An "Awareness Paper" for Application Support / Application Operations, Operations Managers and Change Managers to avoid unplanned outages.

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The Author of this white paper is an

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