CS298 Report

Schemes to make Aries and XML work in harmony

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Agenda

- Our project goals
- ARIES Overview
- Natix Overview
- Our Project Design and Implementations
- Performance Matrixes
- Conclusion

Project Goals

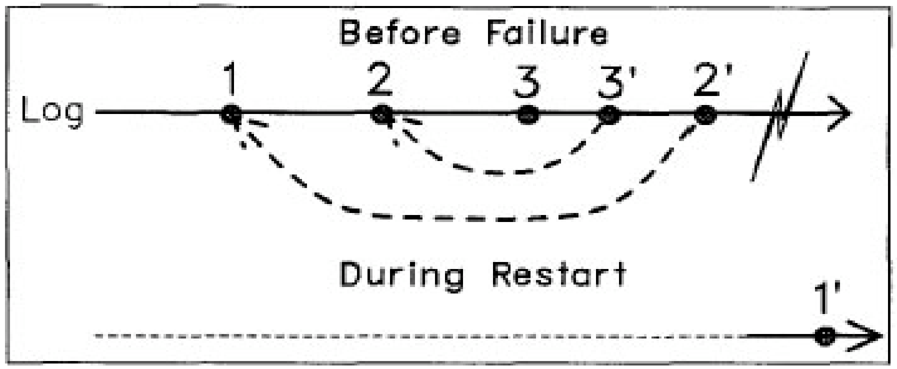
- Develop an XML toy database.
- Implement ARIES and Natix's recovery mechanism.
- Support basic operations: insert, load, update, delete, commit, and rollback.
- Allow some basic commands such as printTree, and archive.
- Let user to vary the data page's size and the buffer pool's size (for page swapping experiments).
- Set up a test environment for user to experiments

Introduction

- In general, there are three phases:
  - Analysis:
    - read the log records from the last system checkpoint
    - analyze them
    - build a list of actions for the redo and undo phases
  - Redo
    - Use log records to bring the dirty data pages updated by all transactions to a point in time (consistency point – no update operations allow)
  - Undo
    - Use log records to undo updates made by un-committed transactions

ARIES Overview

- Buffer management uses steal/no-force policy:
  - Steal: flush dirty page(s) by a transaction onto disk before the transaction commit.
  - No-force: page(s) modified by a transaction does not have to be flushed onto disk when the transaction commits
- All update operations must be logged using log records.
- Use write-ahead logging protocol:
  - A log record must be created on storage before the update operation can be completed.
- Undo operations are also recorded using compensation log records (CLR):
  - Log record written for rollback operation to say what has been rolled back. (no need to recover what has been rolled back.)



I′ is the Compensation Log Record for I
I′ points to the predecessor, if any, of I

Figure 1 - CLR

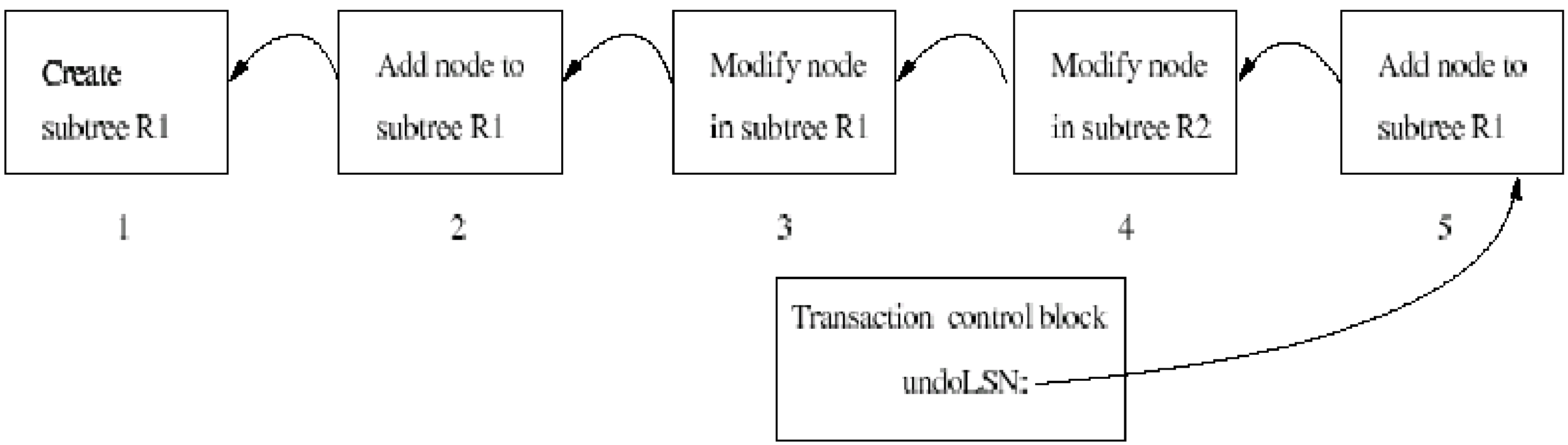


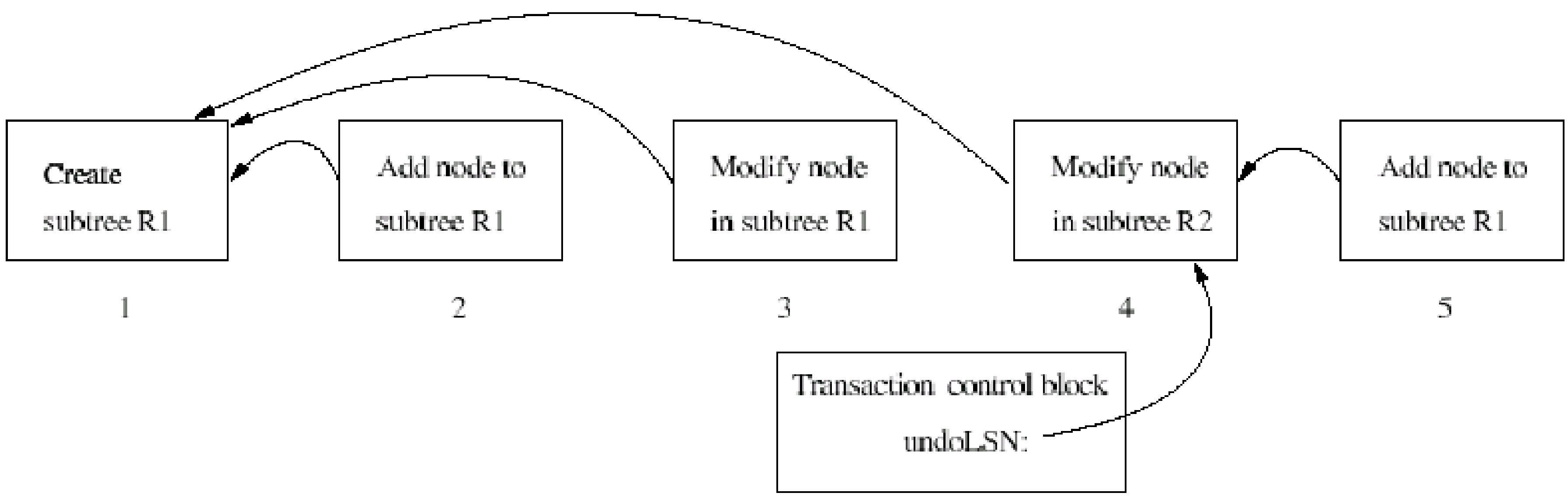
Figure 2 – Subsidiary Logging

Natix Overview

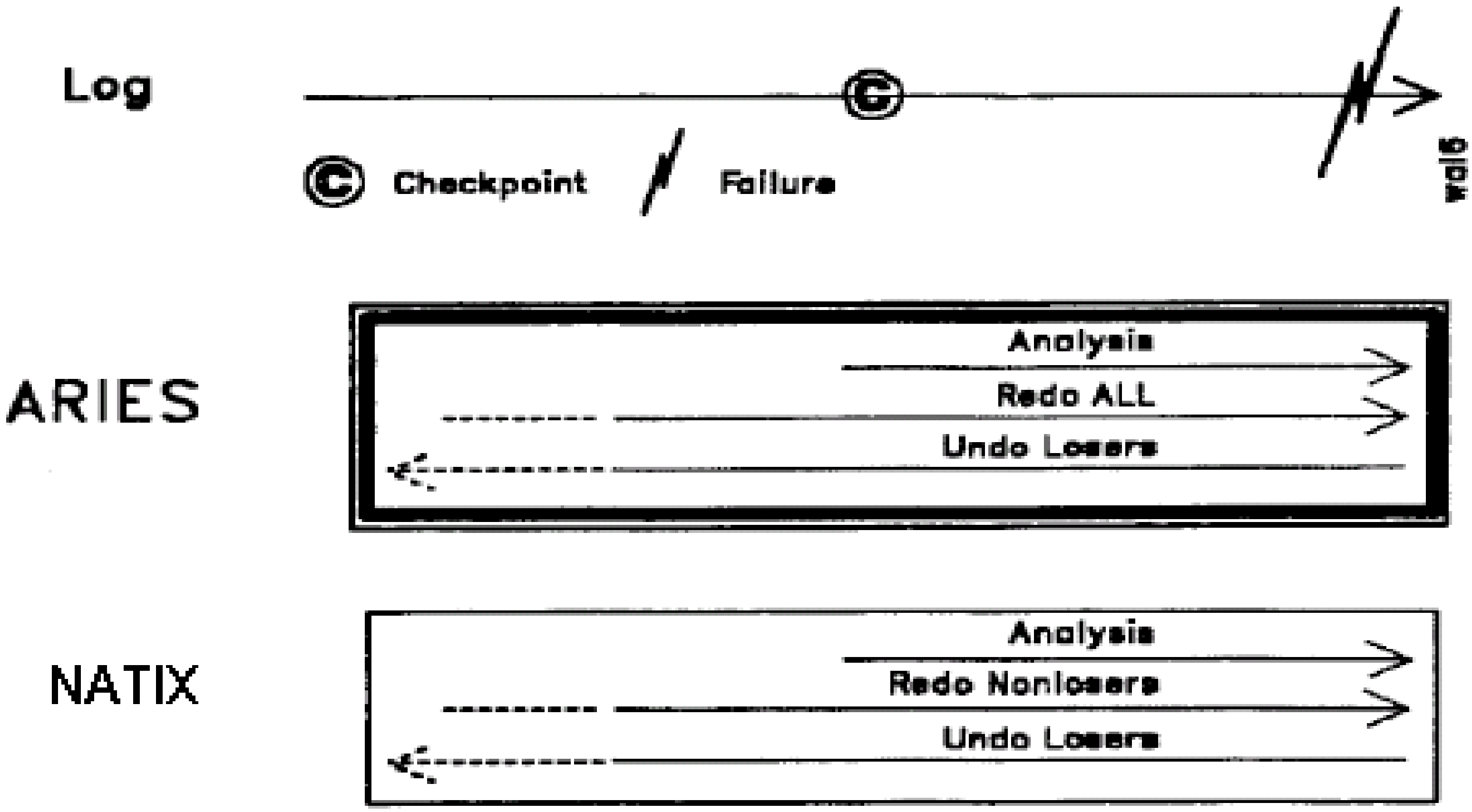
- Same as ARIES but modify the way log records written during forward phase.
- Subsidiary Logging:
  - Page interpreter keeps a private log for updates to the same transaction, onto the same page.
  - The log content is locally modified to reduce the number of log records.
  - Subsidiary log’s content is published to log manager right before a page is flushed to disk (according to WAL) or the transaction commit.
- Undo operations also be recorded using compensation log records.
- Selective Redo:
  - Use log records to bring dirty pages (updated by committed transactions) to a point in time from the last image copy.

Annihilator Undo

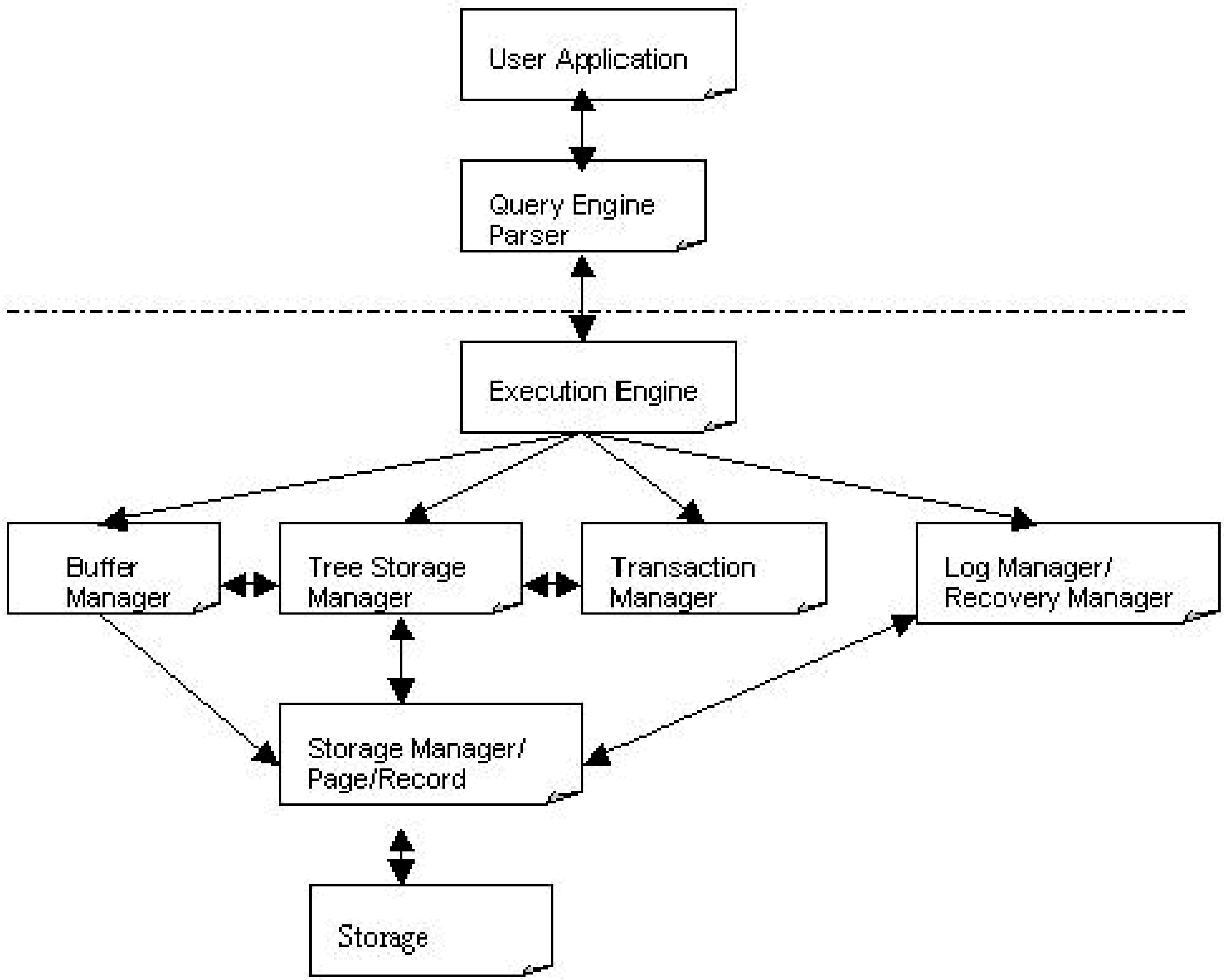
- Updates to a record that created by the same transaction need not to be undone when the transaction is aborted as the record will be deleted anyway.
- Instead of undo 5, 4, 3, 2, 1, undo 4, 1 would be enough.



Recovery Management



Design of the toy Database (p. 16)



XML Documents Example

```
<XML ID="00000001">
    <G name="CS297">
        <G id="123-45-6789">
            <L>Jane Eyre</L>
        </G>
        <G id="234-56-7890">
            <L>Irene Hugh</L>
            <L>3.0</L>
        </G>
    </G>
….
    </XML>
```

Logical Tree Structure (p. 19)

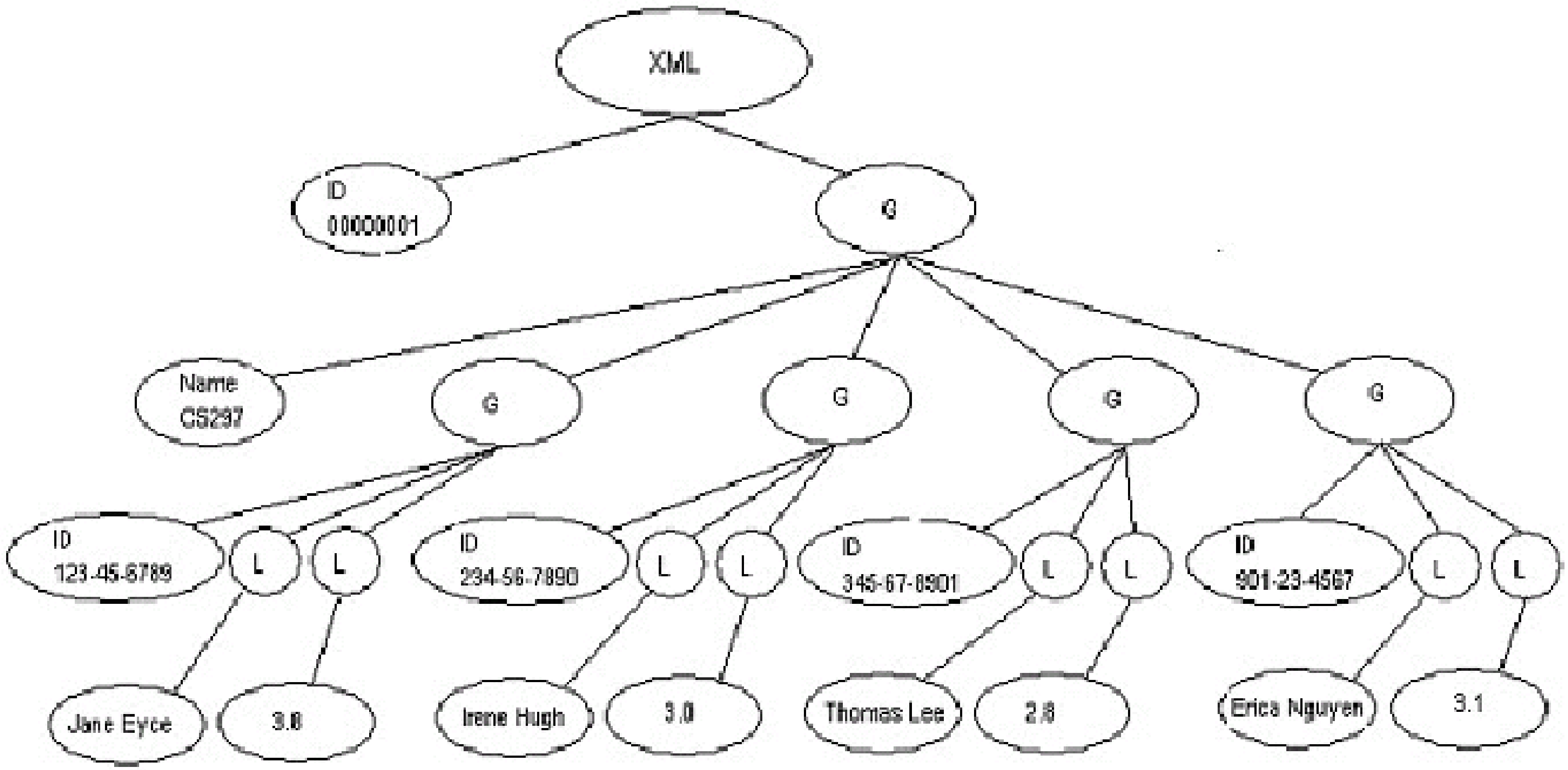


Figure 9 – Logical Tree Associate with Its XML Document

Query Engine (p. 17)

- Includes:
  - query compiler, query parser, query preprocessor, and query optimizer.
- We support:
  - query parser
    - Parses tags: <XML>, </XML>, <G>, </G>, <L>, </L>. (=> language is simple but can have an arbitrary tree structure)
    - Parses grammar: <G>, and <L> tags can be nested inside <G> tags. <L> tags can't be nested.
    - Parses queries: insert, update, delete, rollback,…
    - Parses commands: printTree, archive,…

Some DDL/DML statements

- Data Definition Language
  - Statements that are used to define objects.

Example of a DDL statement

```
T1 CREATE DATABASE DB1DB;
T1 CREATE XMLDOC XML1DOC IN DB1DB;
```

- Data Manipulation Language
  - Statements that are used to modify, manipulate objects.

Example of a DML statement

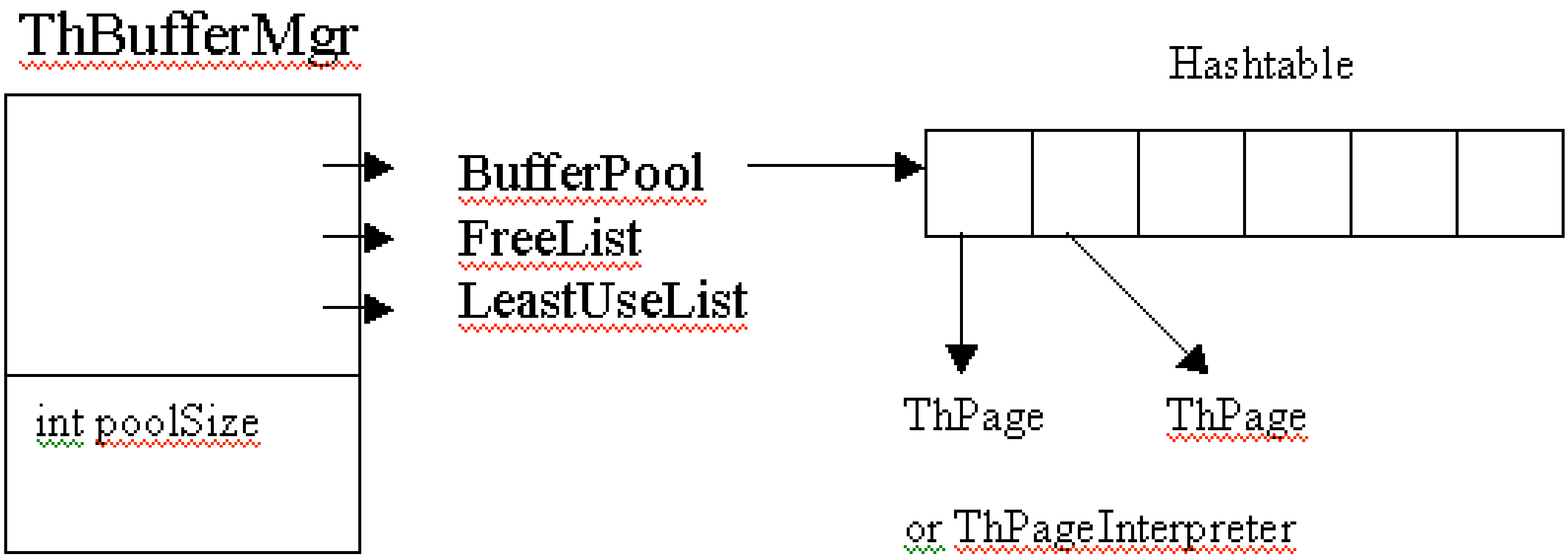
```
T1 INSERT INTO XML1DOC PATH("/G/G[1]/L") VALUES("<L>Jane
Eyre</L>",
                                        "<L>3.8</L>");
T1 COMMIT;
T2 UPDATE XML1DOC SET VALUE("<L>392 Lulu Ahh Dr., San Jose CA
                    95123</L>")   WHERE
```

Execution Engine

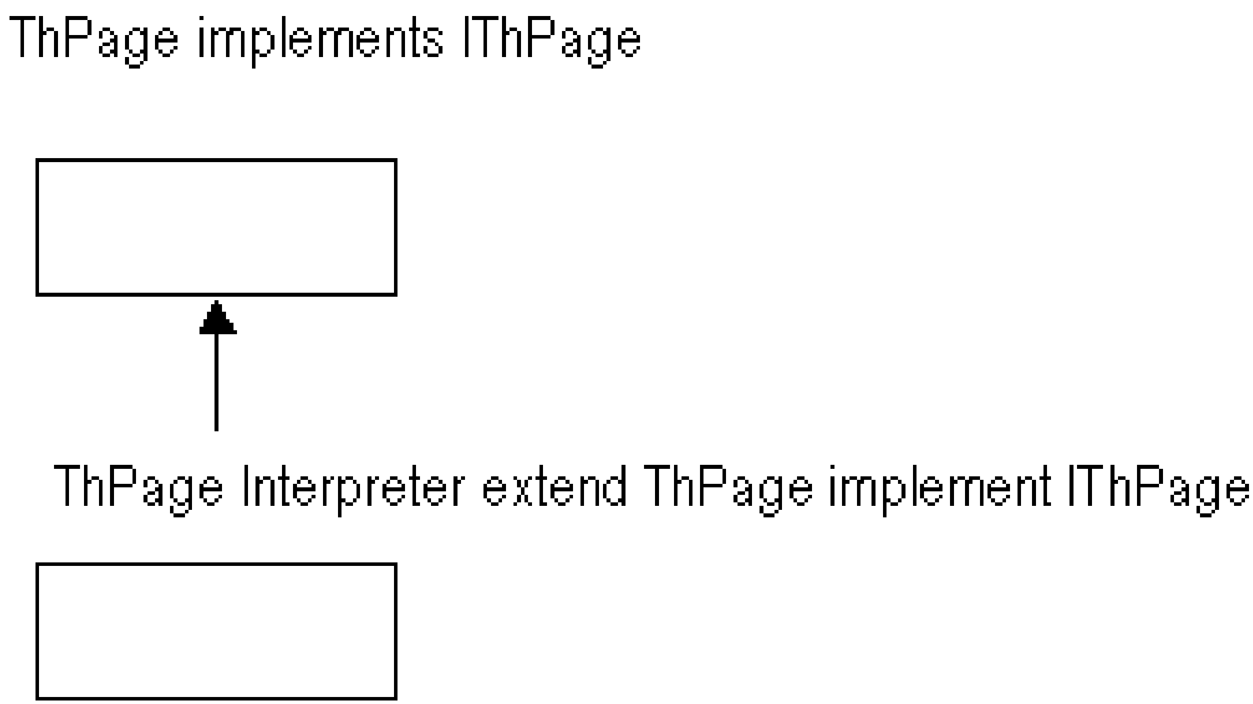
- Has input which are either queries, and/or commands.
- Drives the execution for each query/command.
- Returns the result back to user application (printTree).

Buffer Manager (p. 18)

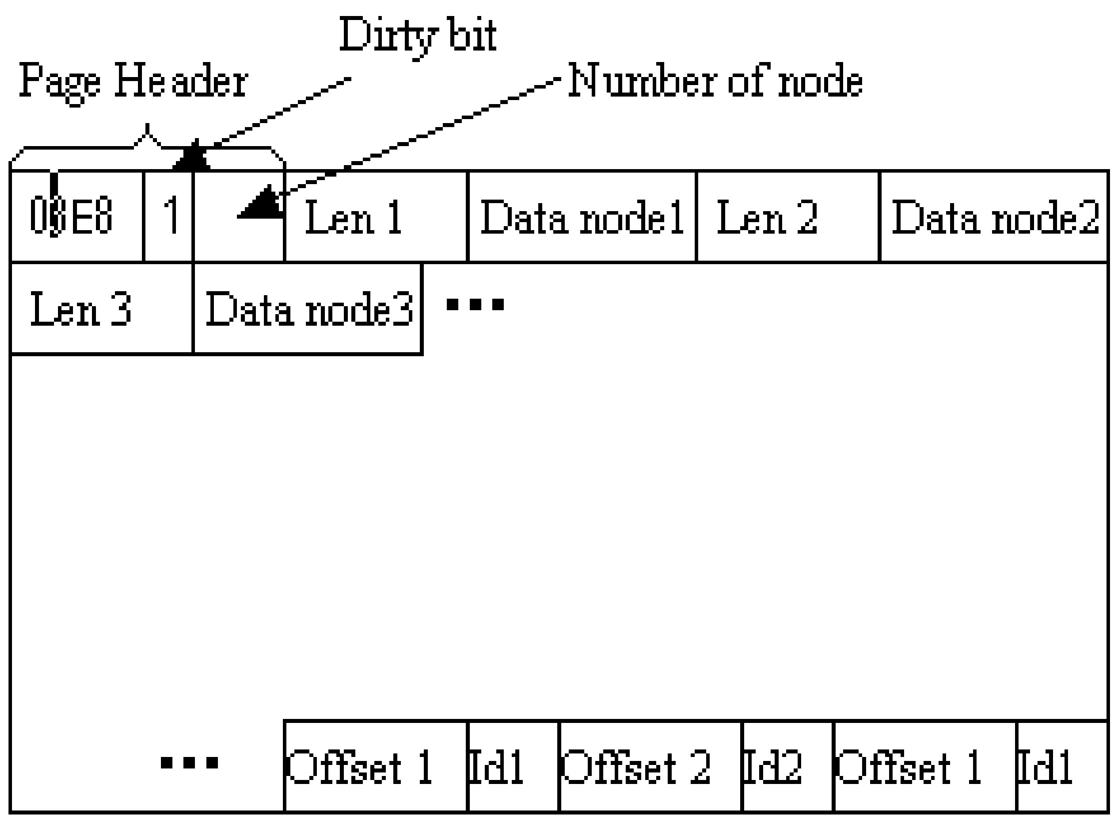
- Allocates, manages, and de-allocates pages in the buffer pool.



The ThPage and ThPageInterpreter Relationship (p. 18)



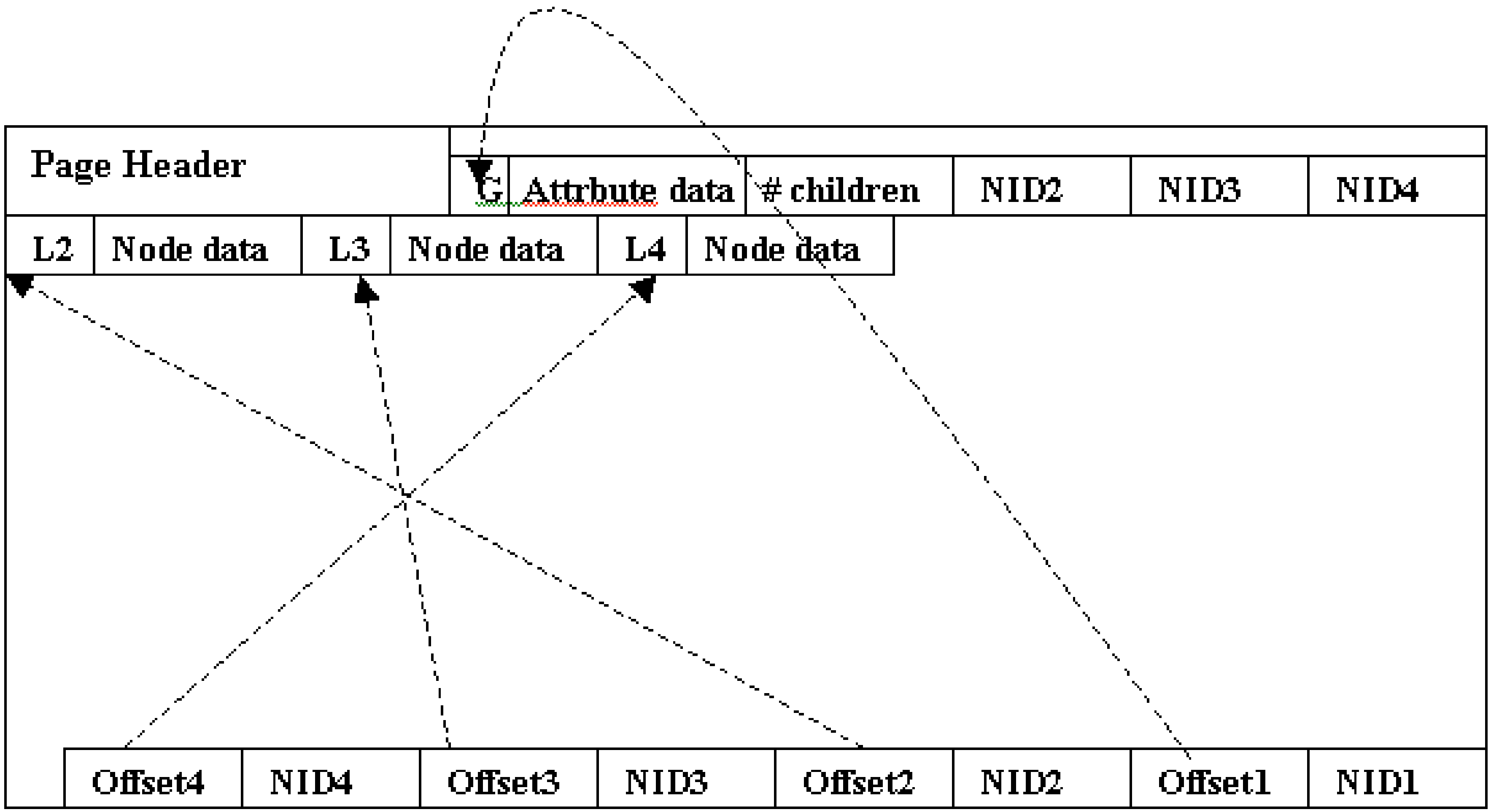
ThPage and ThPageInterpreter space management (p. 23)



ThPage and ThPageInterpreter space management

- Data Structure:
  - 2 bytes page number
  - Half byte dirty bit
  - 2 bytes number of nodes in a page (maximun nodes in a page is 255)
  - ArrayList of nodes
- Functions support: decode/encode for read/write operations.
- The only different between ThPage and ThPageInterpreter is ThPageInterpreter does subsidiary logging.

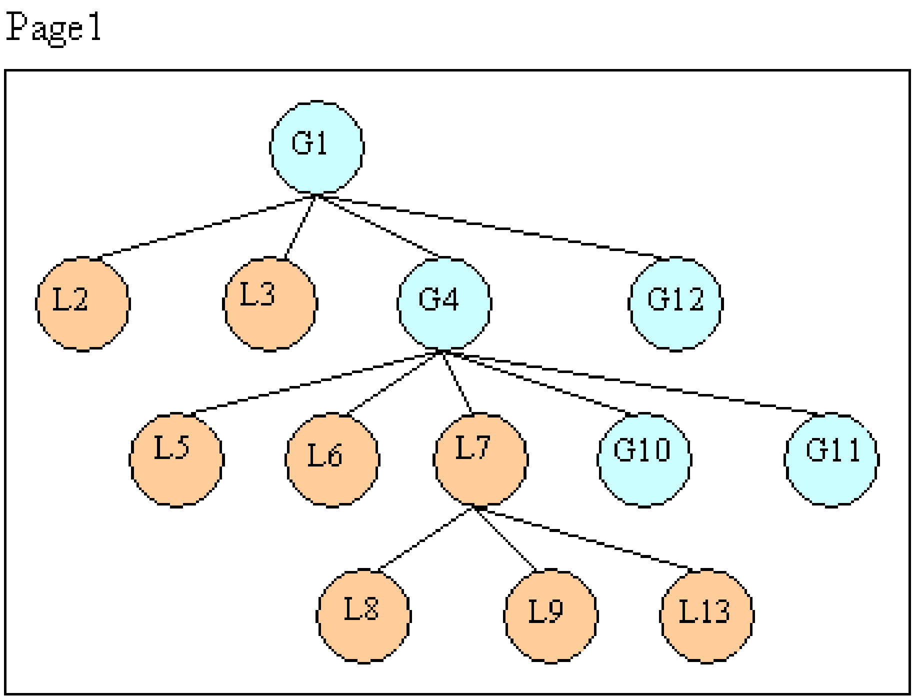
ThStructMapPage (p. 21)



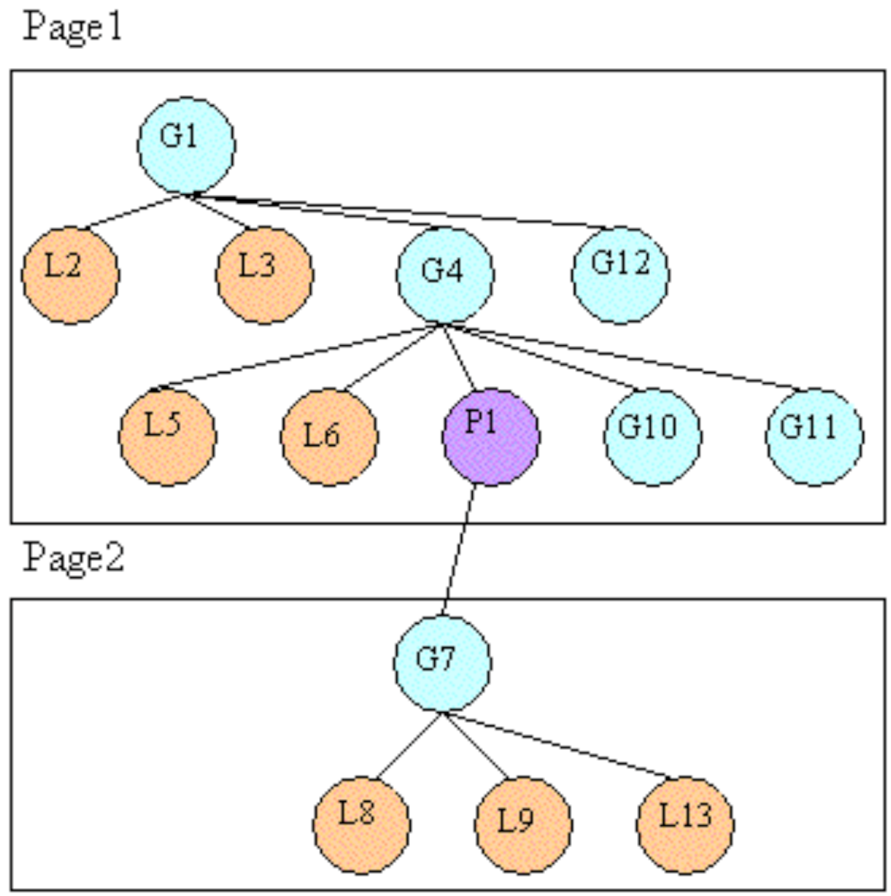
Tree Storage Manager

- Construct and manipulate tree structure object at the logical and physical level
- Implemented in class ThXMLDoc
  - Keeps track of a set of pages that contain the tree structure document (called pageSet)
  - Has pointer to the root node

Page Split (p. 22)



Before Split



After Split

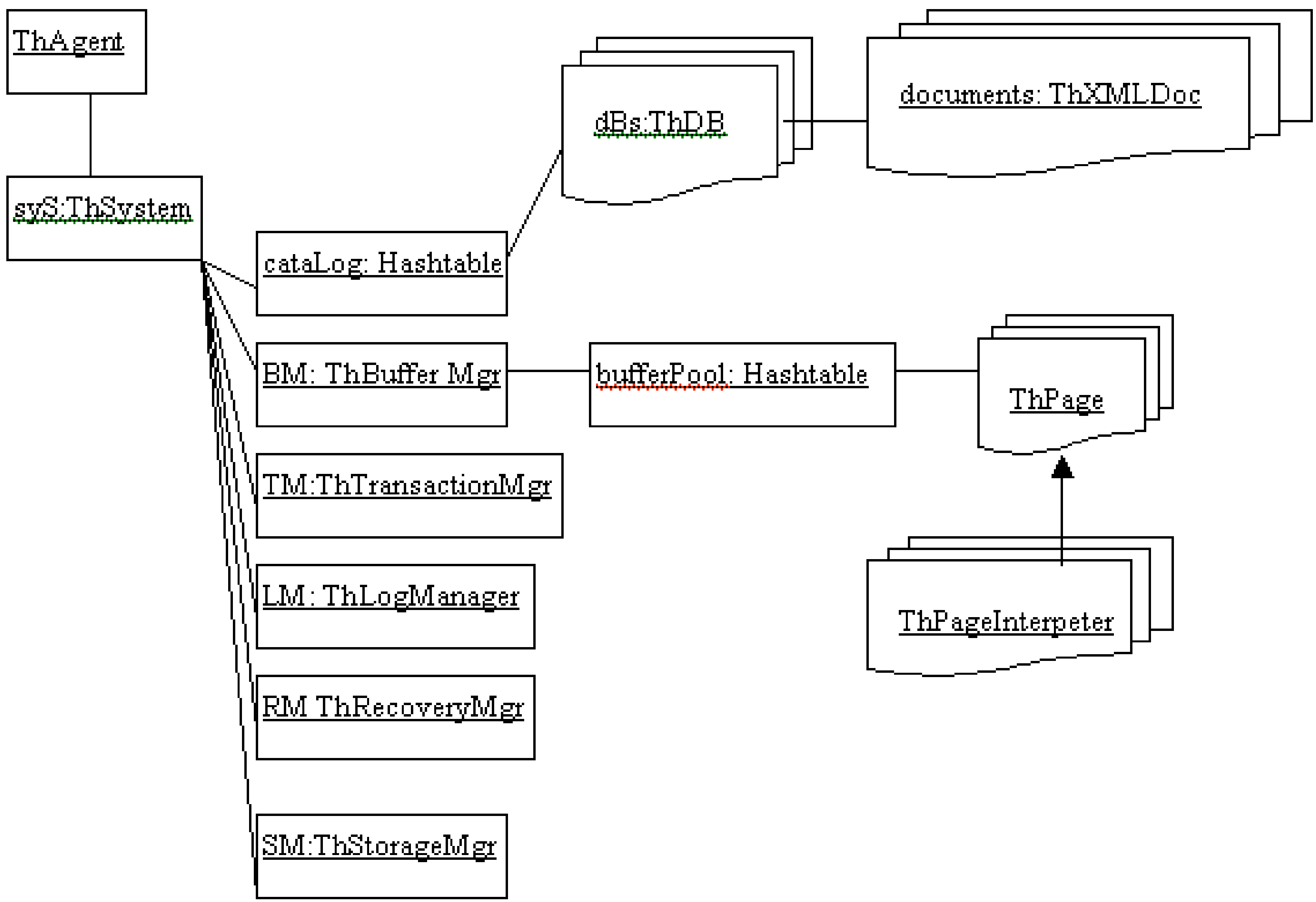
Transaction Management

- Contains a Hashtable of transaction
  - A transaction
    - Transaction ID
    - Its current state (committed or not)
    - List of LSNs

Log Management

Reads and writes log records

UML for Object/Classes (p. 16)

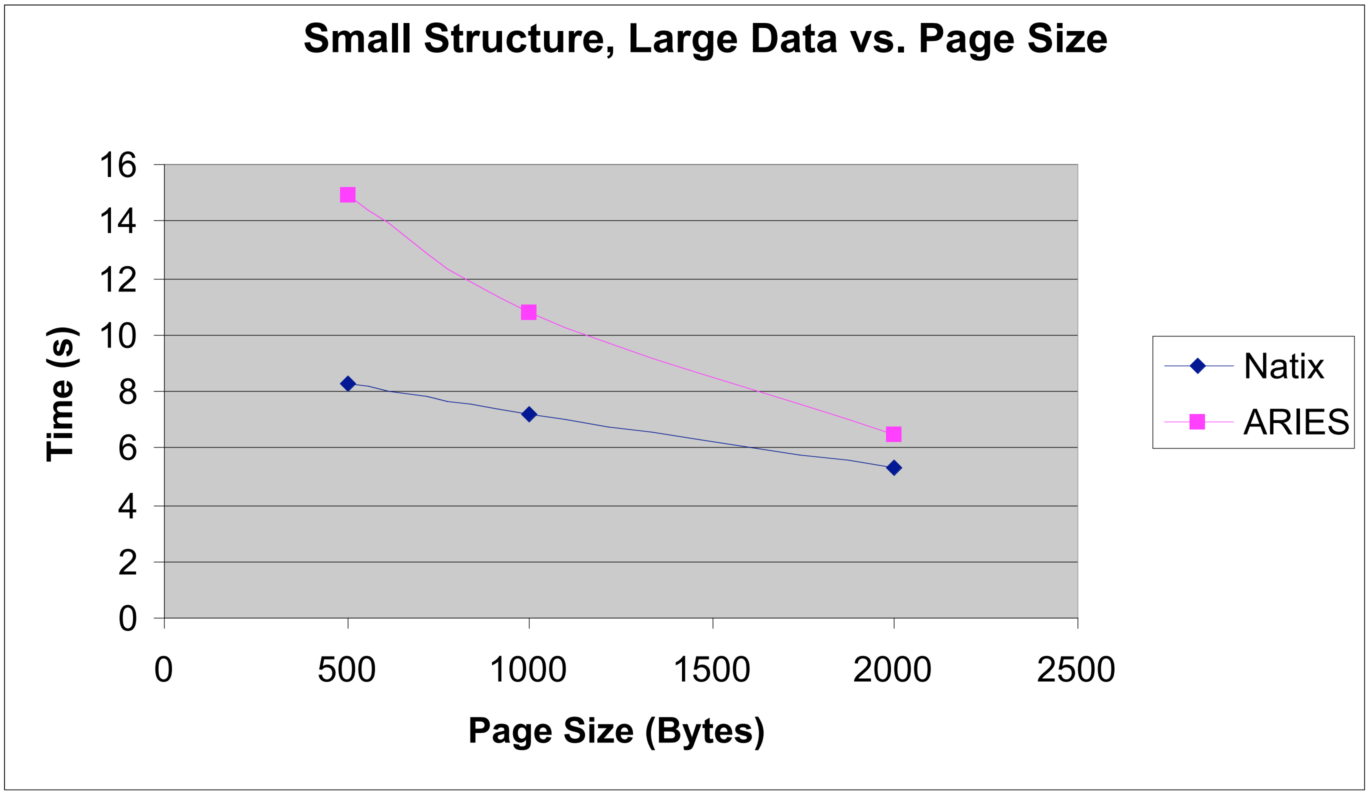


The dbsystem.properties file

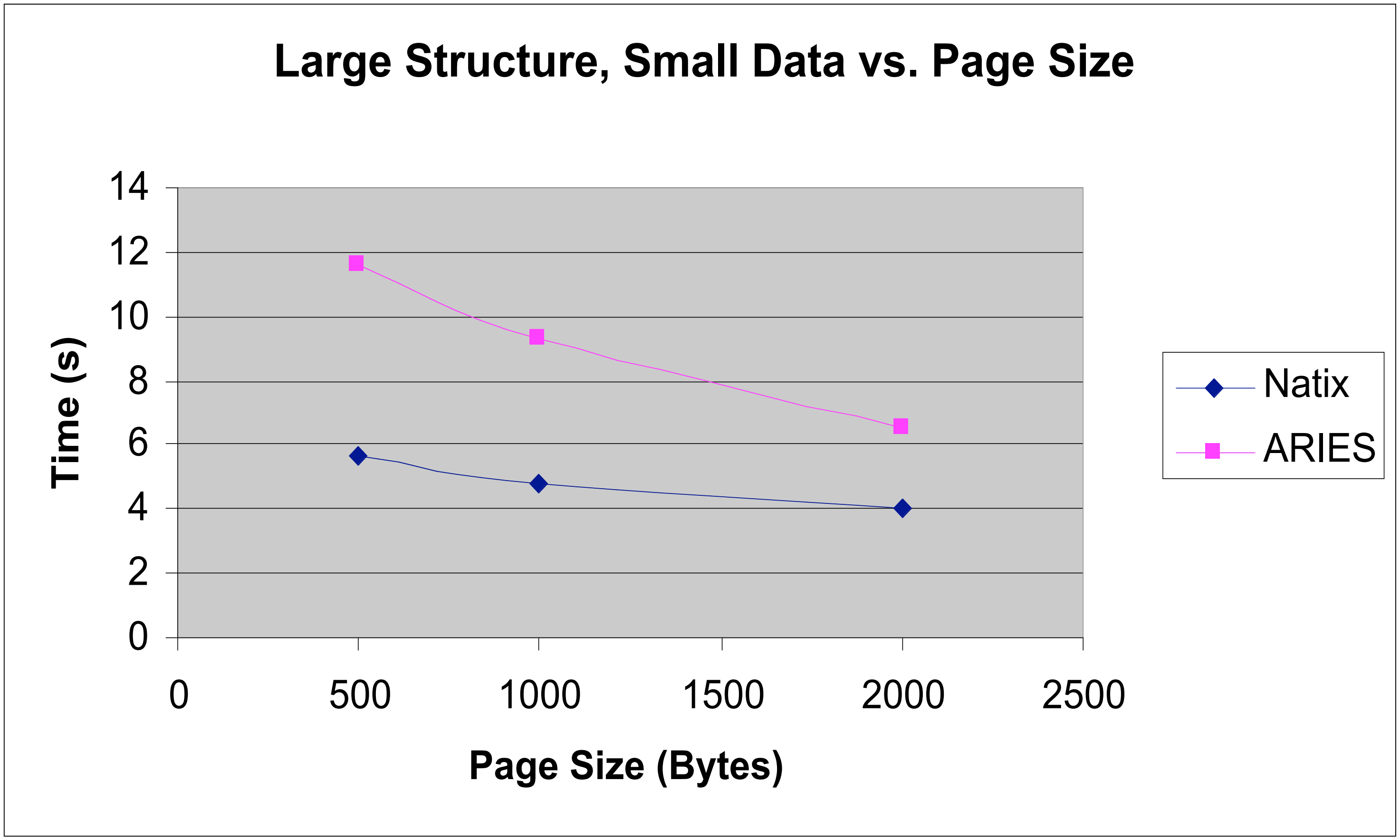
- Used to specify system initial values
- For example:

```
pageSize = 500
recoverMethode = ARIES
# The following section is random test generator parameters
numberOfNodes = 500
randomOutFile = c://an//cs297/xmldb//src//sm//input//randomTest.txt
insertWeight = 7
updateWeight = 3
deleteCount = 4
# paragraph = alsk
djflsaksjfjfMXc.,.,xzMCz.,mczx.,lklksdfgfds?.,mczxmcC`12222345z.mcxzMCal
ksd832~!@##$%^&*_+=-][po}{asdfghjkl][poiuytrewq1234567890-
=,mnbvcxz>?:+_*&^%$#@!`.,
paragraph = t est
```

Performance Experiments (p. 56)



Performance Experiments (p. 58)



Challenges

- Some of the challenges:
  - Natix and ARIES's design and implementation
  - Space storage management
  - Buffer manager design and implementation
  - Tree manager design and implementation

Future development

- Some of the area the can be added, improve in the future:
  - Lock management
  - Can be extended to model client-server environment
  - Fast Log applies for recovery management.
  - Defer recovery.

Conclusion (p. 59)

- We developed a toy XML database management system (DBMS) useful for studying recovery and buffer management issues.
- Our system is capable of storing XML document that span over pages
- Our DBMS supports operations and commands such as create, insert, update, delete, rollback, commit, load, and printTree
- It supports both ARIES and Natix recovery methods.
- We also established an experimental environment and experimented with page sizes, and recovery methods.