Configuring Apache Derby for Performance and Durability

Olav Sandstå
Database Technology Group
Sun Microsystems
Trondheim, Norway

Overview

- Background
  - > Transactions, Failure Classes, Derby Architecture
- Configuring Derby
  - > Durability of data
  - > Performance
- Performance Tips
- Derby Performance
  - > Comparing Derby, MySQL and PostgreSQL

Properties of Transactions

Atomicity - “all or nothing”

Consistency - “from one valid state to another valid state”

Isolation - “independent of other running transactions”

Durability - “no committed transaction will be lost”

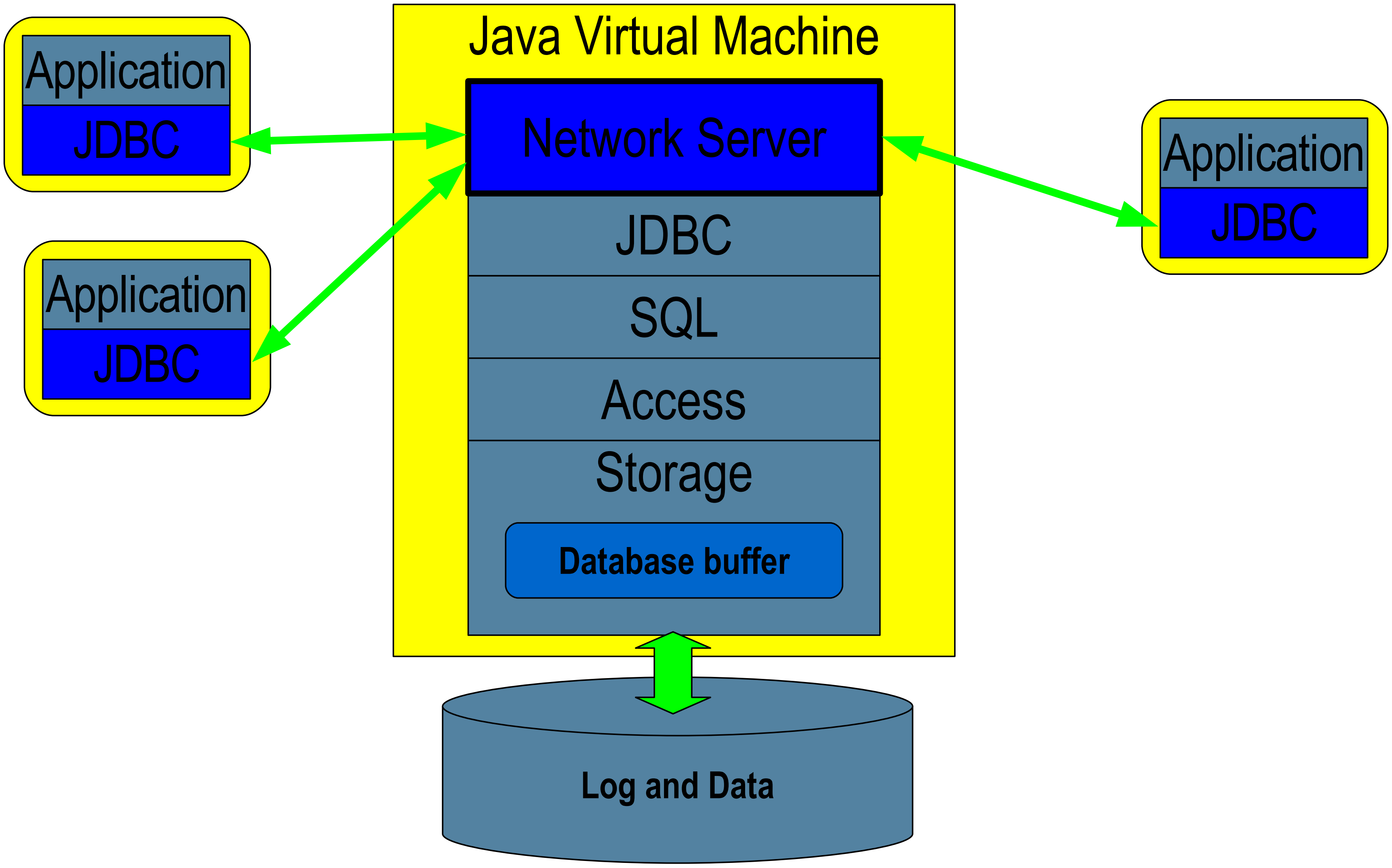
Failure Classes

"If anything can go wrong, it will"

Murphy's Law

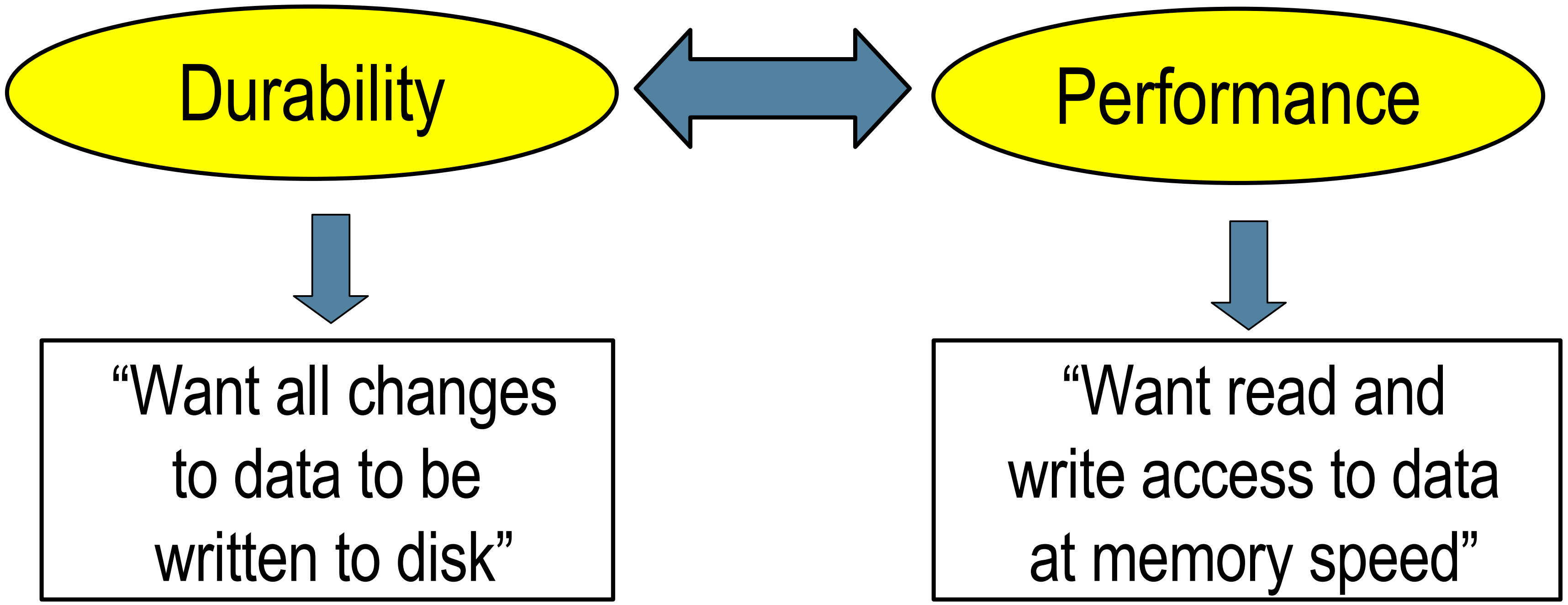
- Process:
  - > Derby or the JVM crashes
- Operating System:
  - > the operating system crashes
- Hardware:
  - > CPU, memory or disks fail
- Site:
  - > fire, earthquakes, etc
- "Drunken DBA":
  - > DBA accidentally deletes or changes data

Derby Architecture: Client-Server



Durability and Performance

Durability and Performance


Durability
Performance
“Want all changes to data to be written to disk”
“Want read and write access to data at memory speed”

Data and Log Devices

Log device:

> Sequential write of transaction log

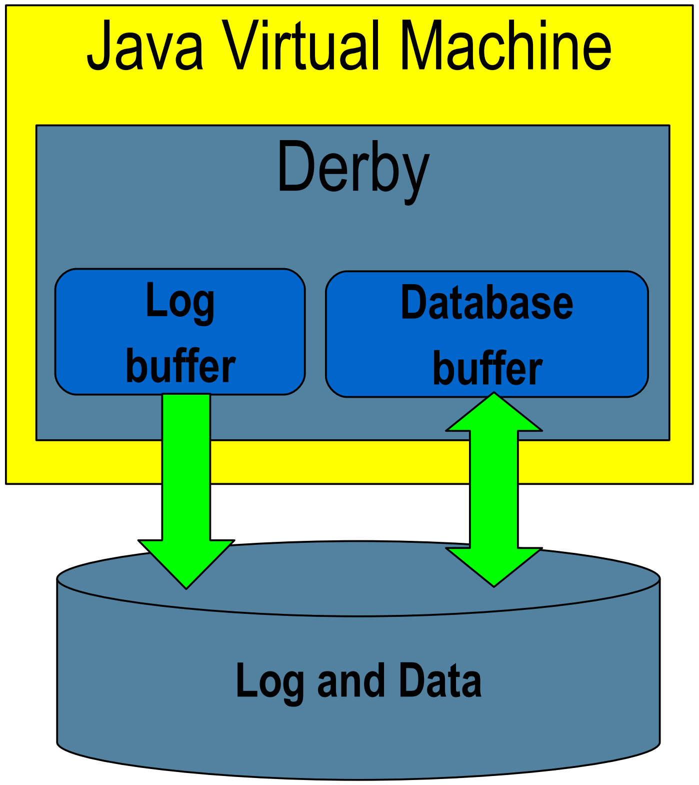
> Synchronous as part of commit

> Group commit

Data device:

> Data in database buffer regularly written to disk as part of checkpoint

> Data read from disk on demand



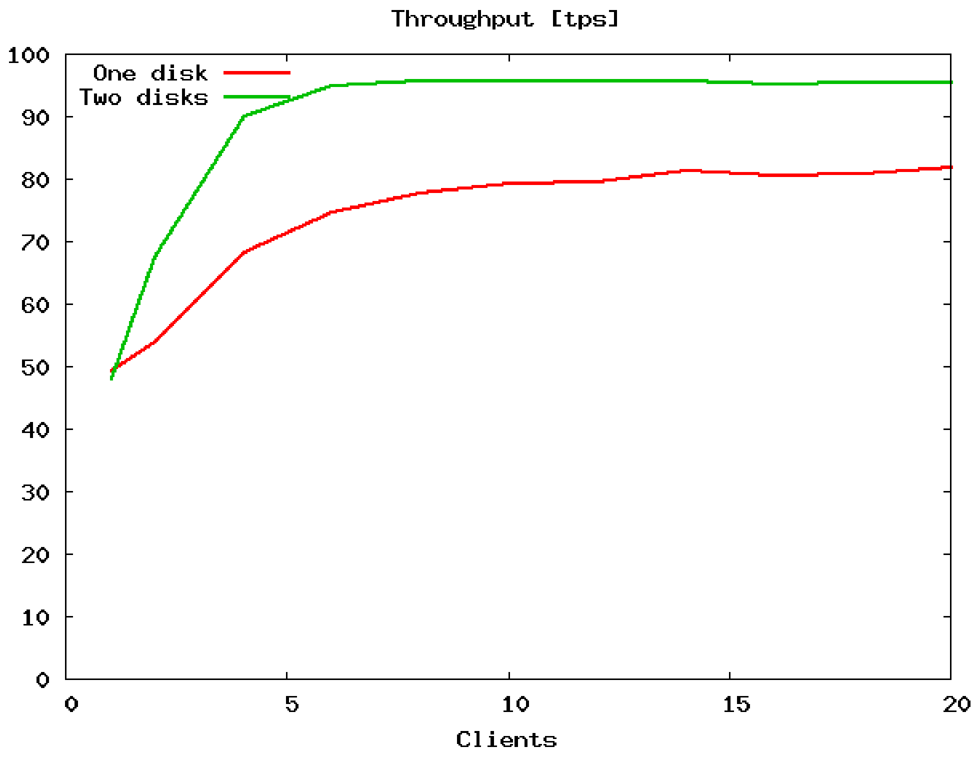
Performance: Separate Data and Log Devices

Log on separate disk:

- utilize sequential write bandwidth on disk
- Configuration:

  JDBC connection url:

  ```
  logDevice=<path>
  ```

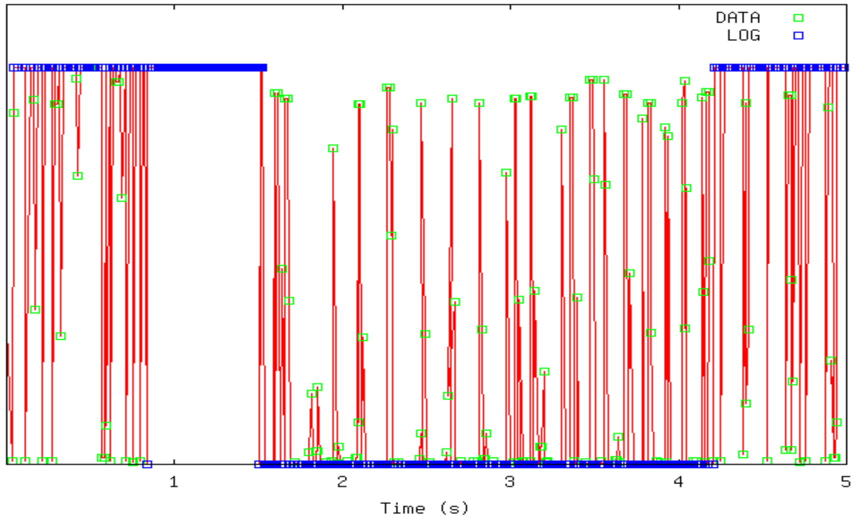


Performance tip:

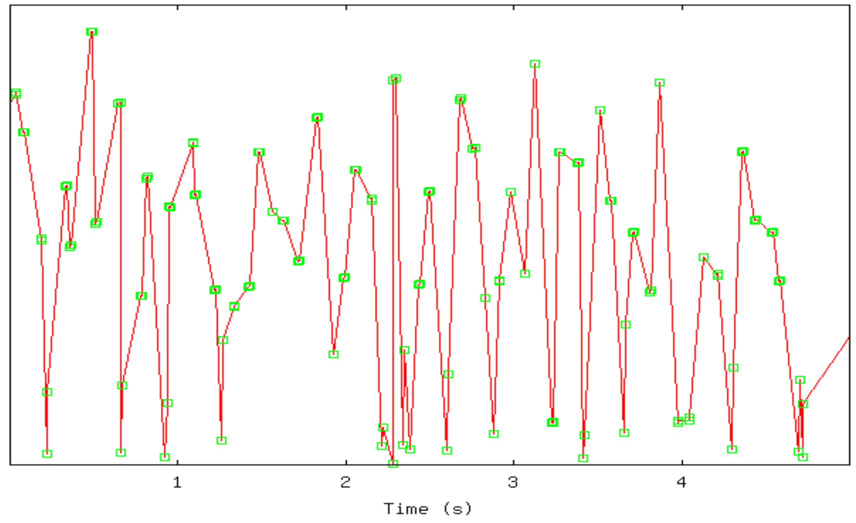
Use separate disks for data and log device

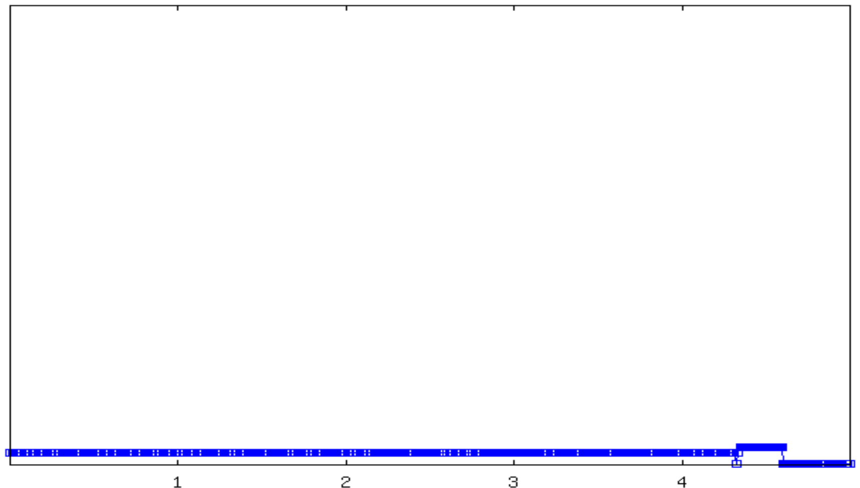
Disk Activity

Data and log on one disk:



Data and log on separate disks:





Disk head movement for 5 seconds of database activity

Performance and Durability: Log Device Configuration

Durability:

- Log to disk before commit

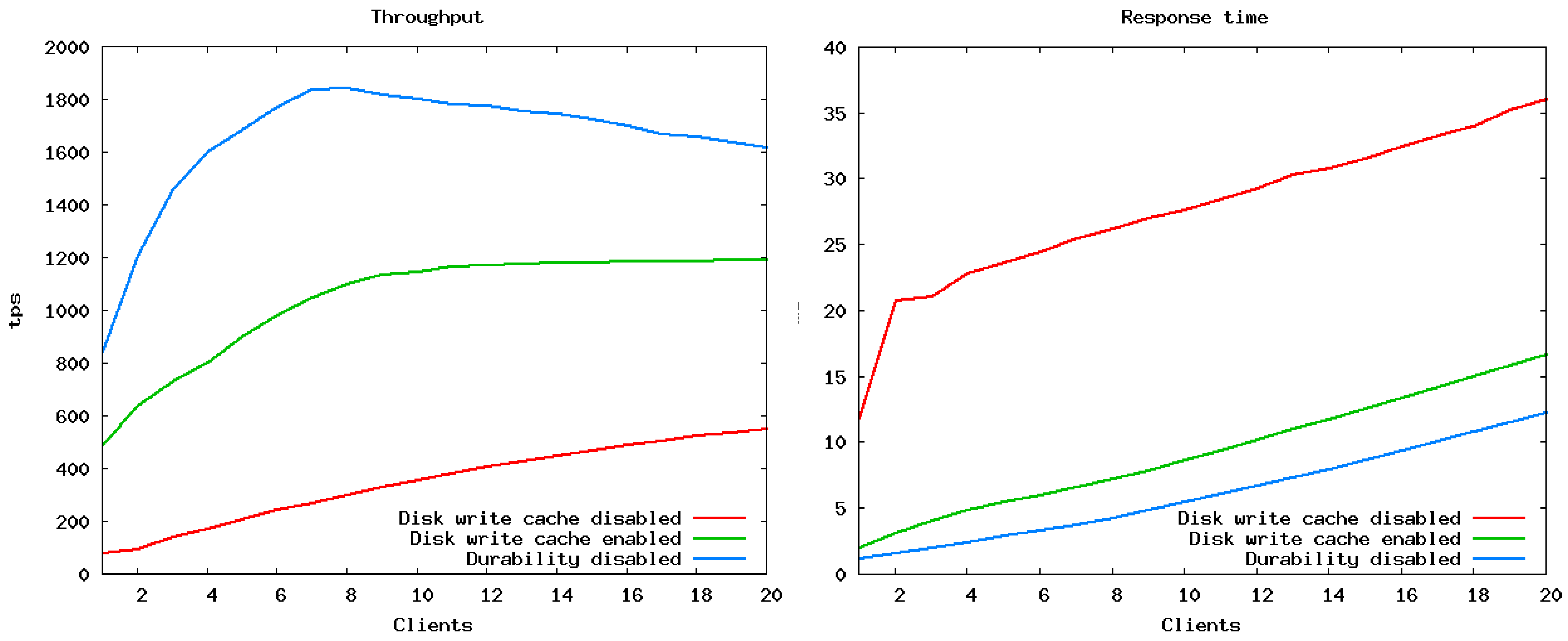
Performance:

- A disk write is “slow” (3-10 ms)

Options:

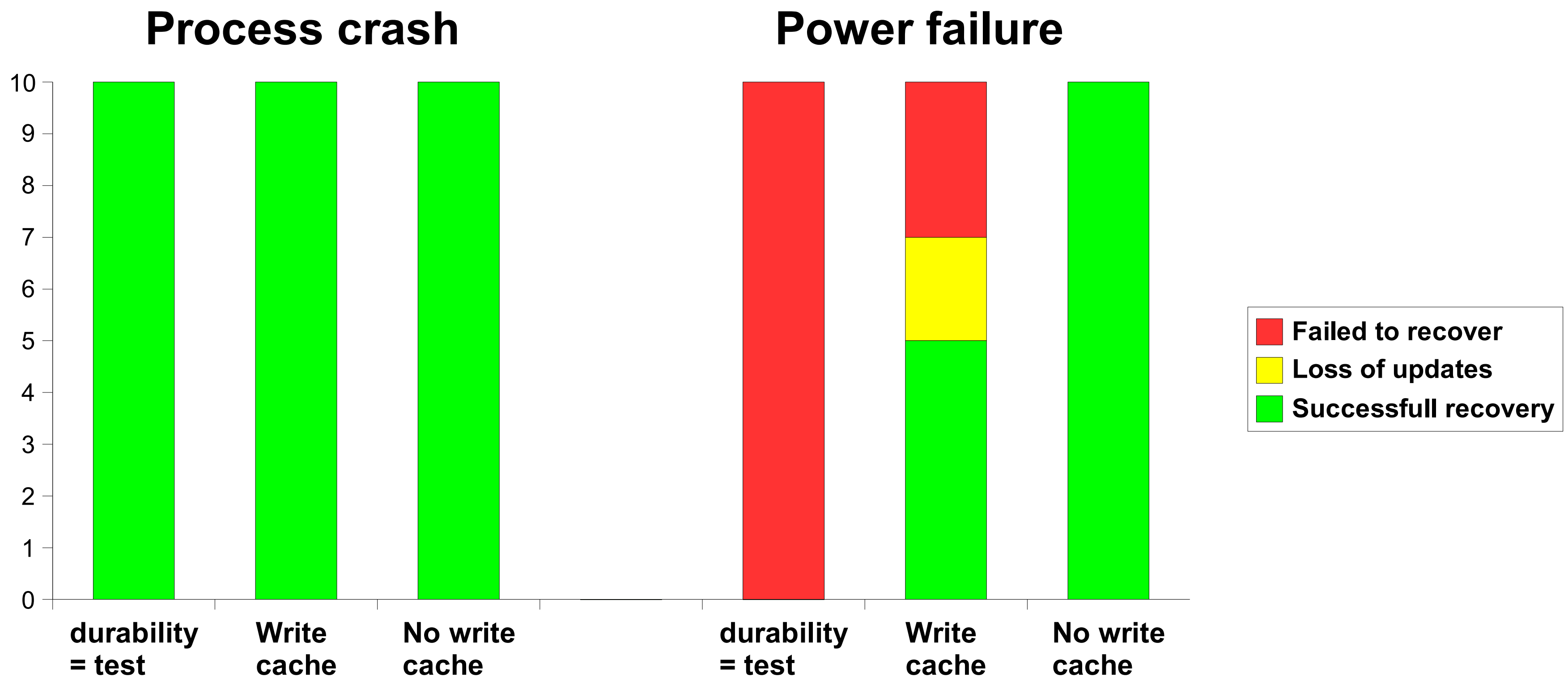
- Disk's write cache:
  - disabled
  - enabled
- Disable durability:
  - derby.system.durability =test

Effect of Disk Log Configurations



WARNING: Write cache reduces probability of successful recovery after power failure

Crash Recovery



Durability tip:

Disable the disk's write cache on the log device

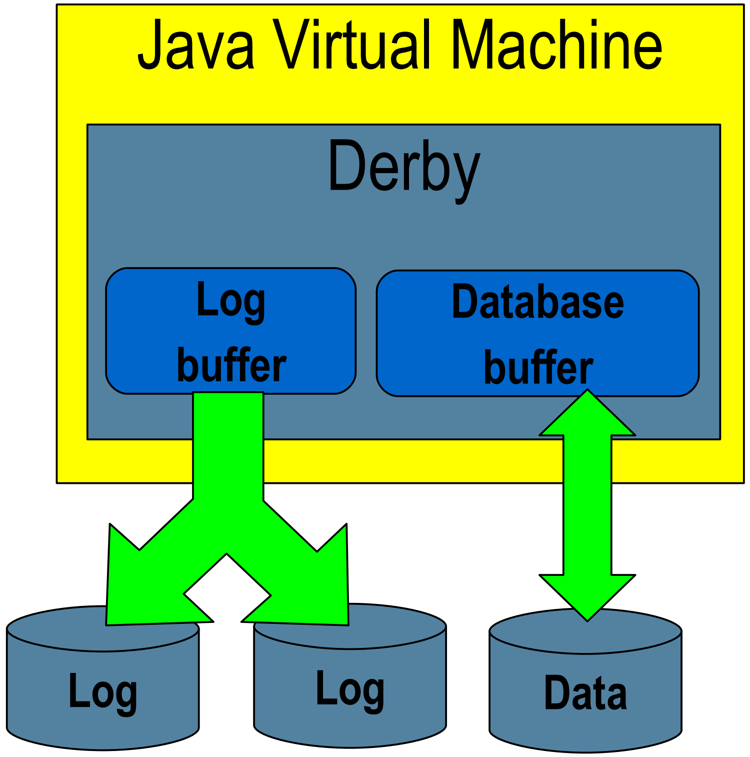
Durability: Preparing for Disk Failures

Log device:

- mirror log on two disks (RAID-1)
- must use OS support for mirroring

Data device:

- backup



Backup

Offline backup:

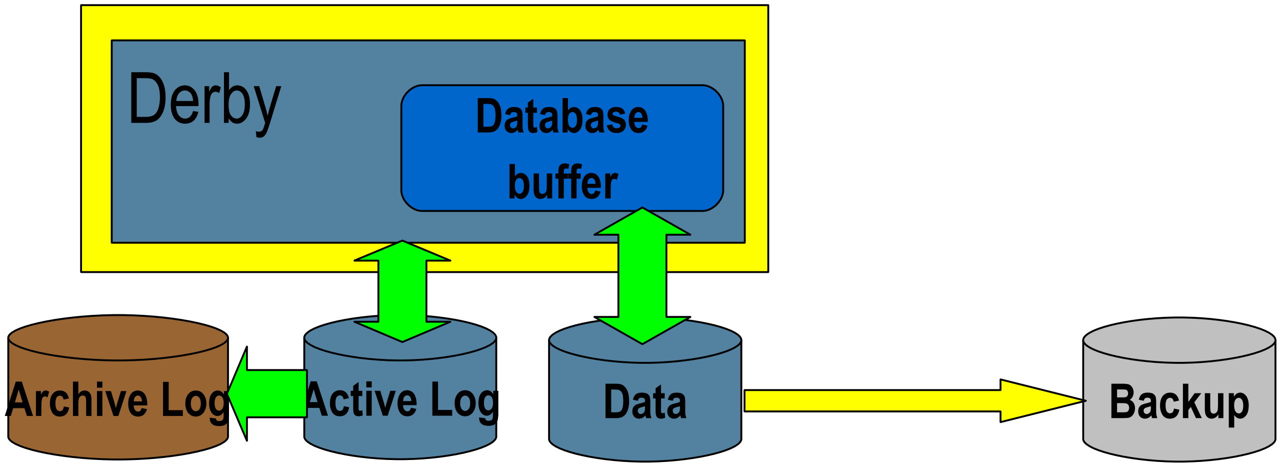
- Stop Derby database
- Copy database files

Online backup:

- Backup while Derby server is running
- New in Derby 10.2: <u>non-blocking</u> online backup
- Supports archiving of log files

Online Backup

- Backup:
  - > SYSCS_UTIL.SYSCS_BACKUP_DATABASE('/home/backup/061012')
- Backup and archive log:
  - > SYSCS_UTIL.SYSCS_BACKUP_AND_ENABLE_LOG_ARCHIVE_MODE('/home/backup/061012', 1)

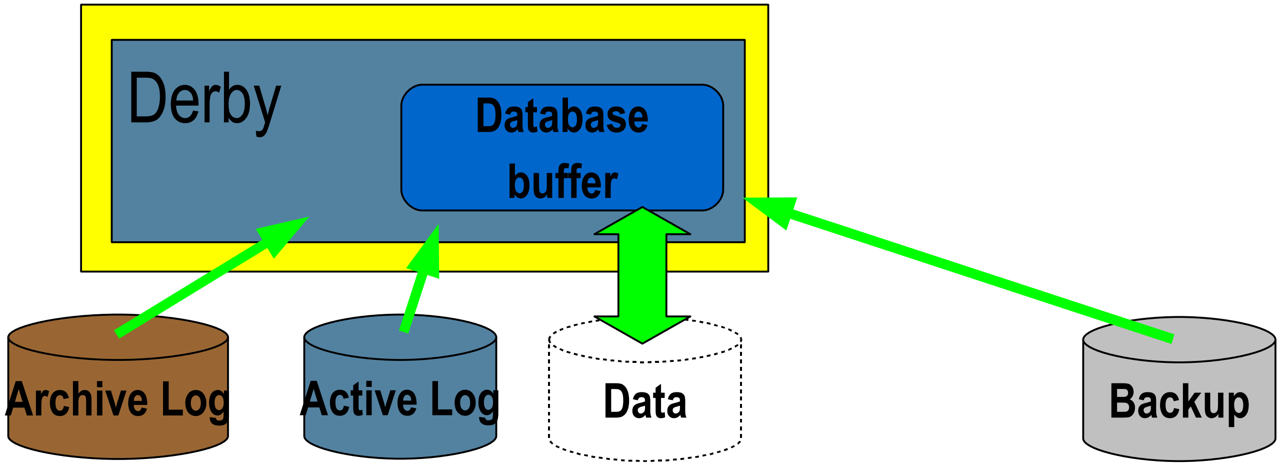


Restore and Roll-Forward Recovery

- Situation:
  - > Database is corrupted
  - > Disk with database has errors

Help!!

- Restore and roll-forward recovery using:
  - > JDBC connection url:
    - 'jdbc:derby:myDB;**rollForwardRecoveryFrom=/home/backup**'



Backup and Restore Strategy

- Define it
  - Derby configuration
    - Mirrored disks for log?
  - Backup configuration
    - Online or offline?
    - Archived log?
  - Restore strategy
- Implement it
  - Ensure it runs regularly
- **TEST IT!**
  - One day you will need it!!

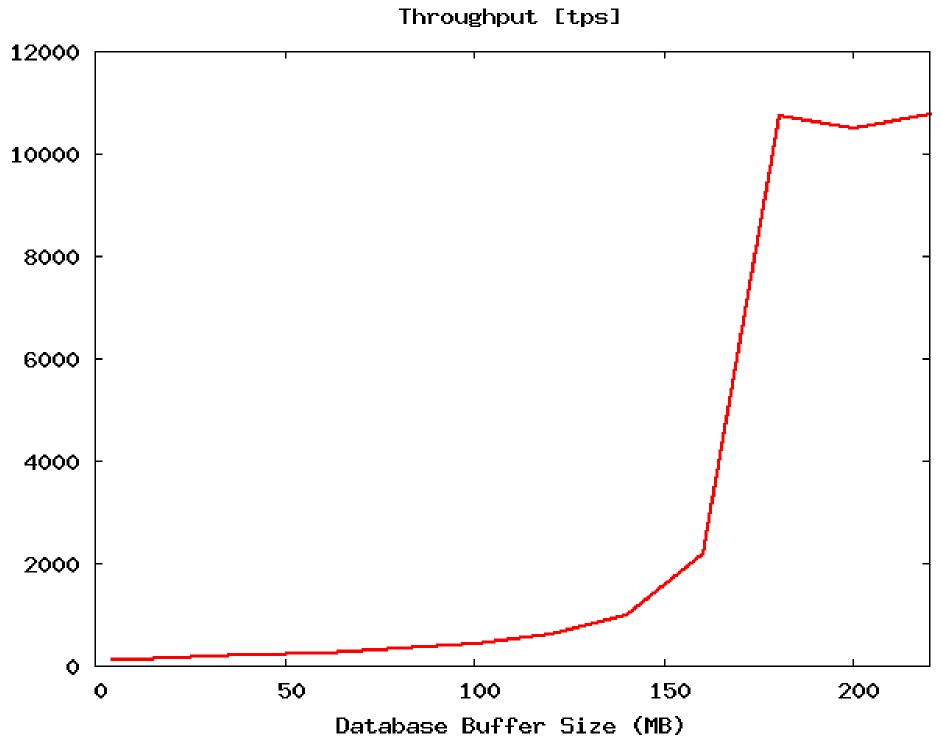
Failure Classes: Summary

Category	Approach
Process crash	Automatic recovery
OS crash	Automatic recovery
Hardware failures	Backup, mirrored log disks, archive log
Site failures	Backup
“Drunken DBA”	Backup

Performance Tips

Performance Tips 1: Database Buffer

- Cache of frequently used data pages in memory
- Cache-miss leads to a read from disk (or file system cache)
- Size:
  - default 4 MB
  - `derby.storage.pageCacheSize`



Performance tip:

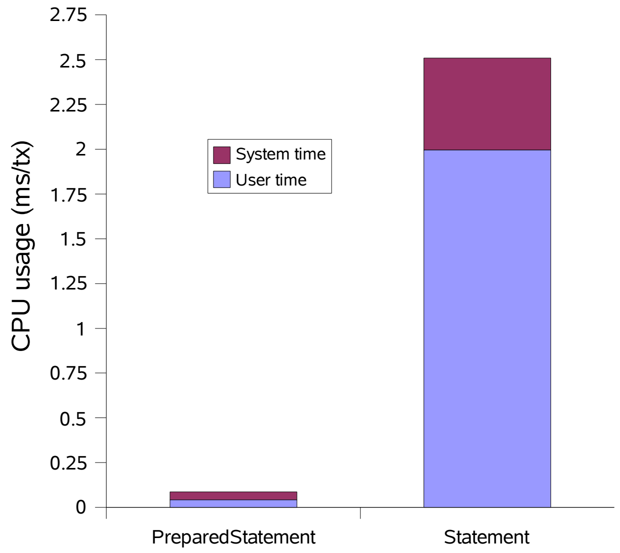
- increase the size of the database buffer to get frequently accessed data in memory

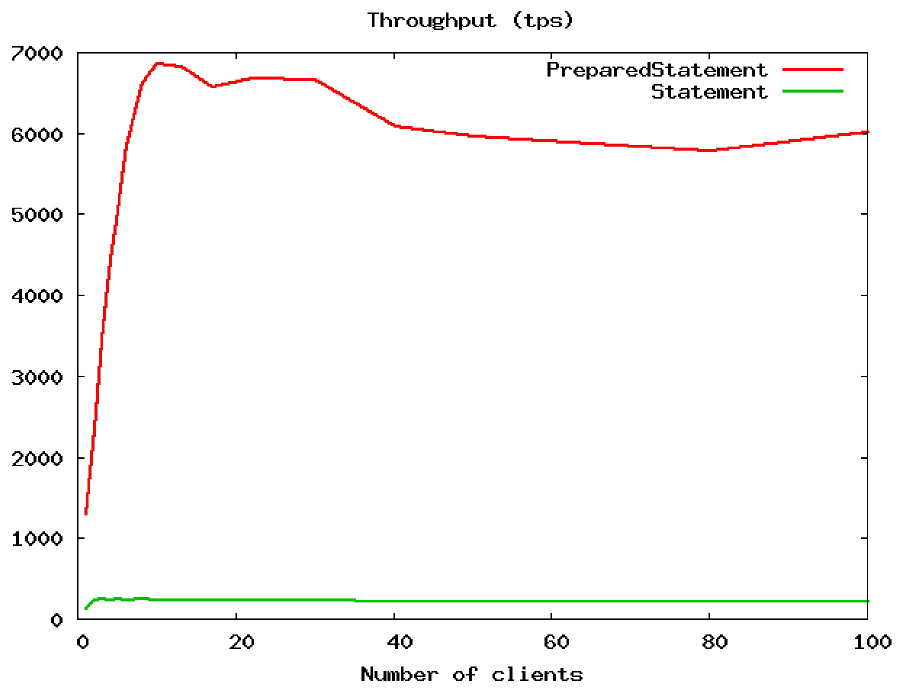
Performance Tips 2:
Use Prepared Statements

- Compilation of SQL statements is expensive:
  - > Derby generates Java byte code and loads generated classes
- Prepared statements eliminate this cost

Performance tip:

- **USE** prepared statements
- and **<u>REUSE</u>** them





Performance Tips 3:
Avoid Table Scans

Two ways of locating data:

- Table scan: reads the entire table
- Index: finds the data by reading a few blocks

Avoid table scans:

- Use indexes to optimize frequently used access paths:
  - `CREATE INDEX....`
- BUT: indexes are not free – needs to be maintained

Performance tip:

- Create and use indexes

Performance Tips 4:
Use the Derby Tools

- Know the load on the database:
  - derby.language.logStatementText=true
- Check the query plan:
  - derby.language.logQueryPlan=true
- Use run-time statistics:
  - SYSCS_UTIL.SYSCS_SET_RUNTIMESTATISTICS(1)
  - SYSCS_UTIL.SYSCS_GET_RUNTIMESTATISTICS()
- Optimizer Overrides (New in 10.2)

Performance tip:

- Use Derby's tools to understand the query execution

Performance of Apache Derby 10.2

Apache Derby 10.2

Performance improvements:

- Client-server:
  - reduced number of round-trips between client and server
  - reduced CPU usage in Derby network server
  - improved streaming of LOBs
- SQL Optimizer:
  - improved optimization
  - support for Optimizer Overrides

30-70% increased throughput on simple queries

Comparing Performance

Databases:

- Derby 10.1.2.1
- Derby 10.2.1.6
- MySQL 5.0
- PostgreSQL 8.0

Load clients:

1. "TPC-B like" load:

> 3 updates, 1 insert, 1 select

2. Single-record SELECT:

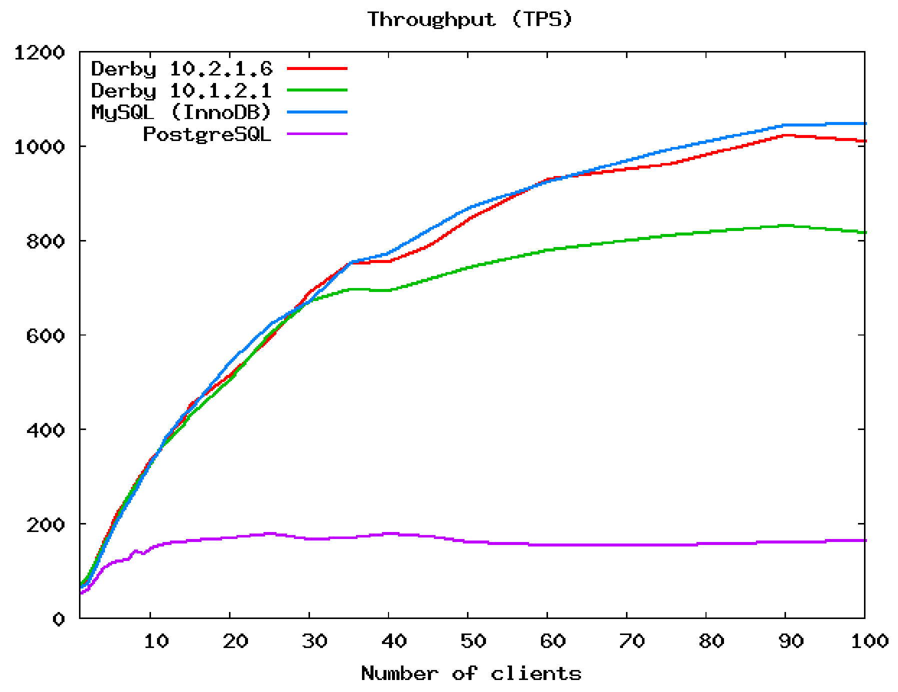
> one record by primary key

Test platform:

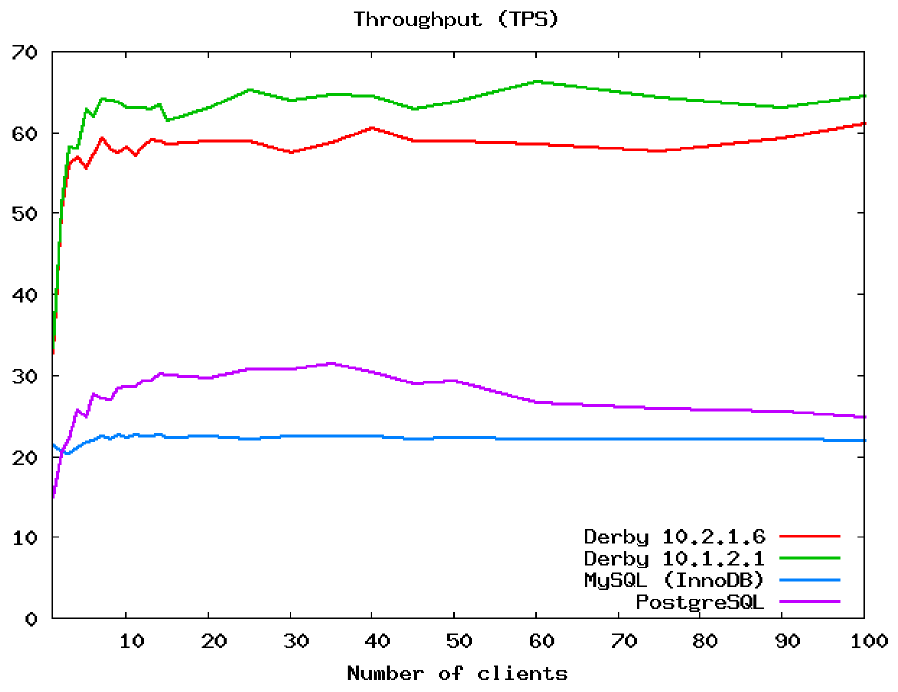
- 2 x 2.4 Ghz AMD Opteron
- Solaris 10
- Sun Java SE 6

Throughput: TPC-B

Main-memory database (10 MB):

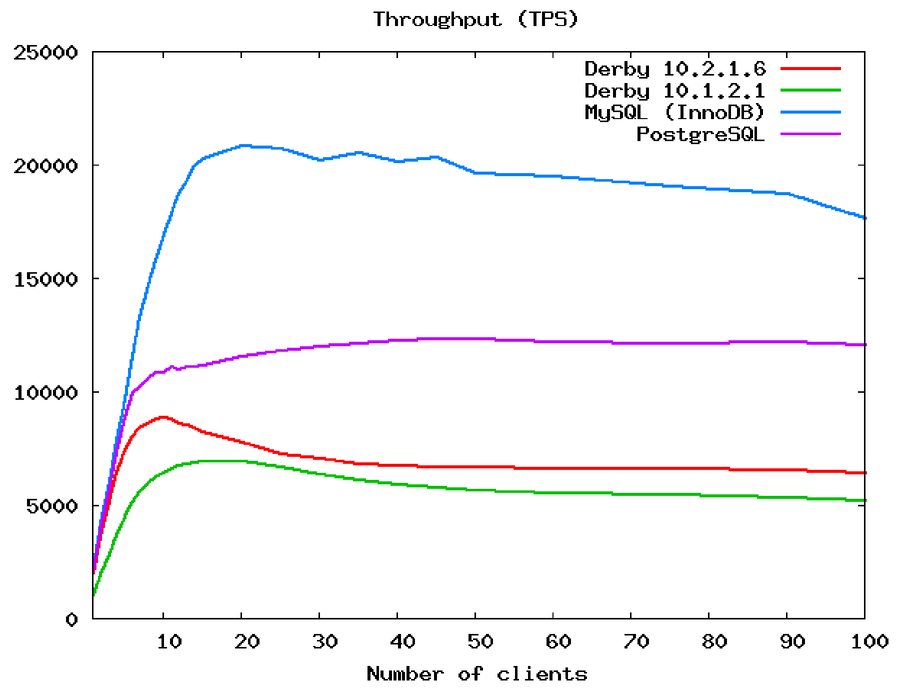


Disk-based database (10 GB):



Throughput: Single-record Select

Main-memory database (10 MB):



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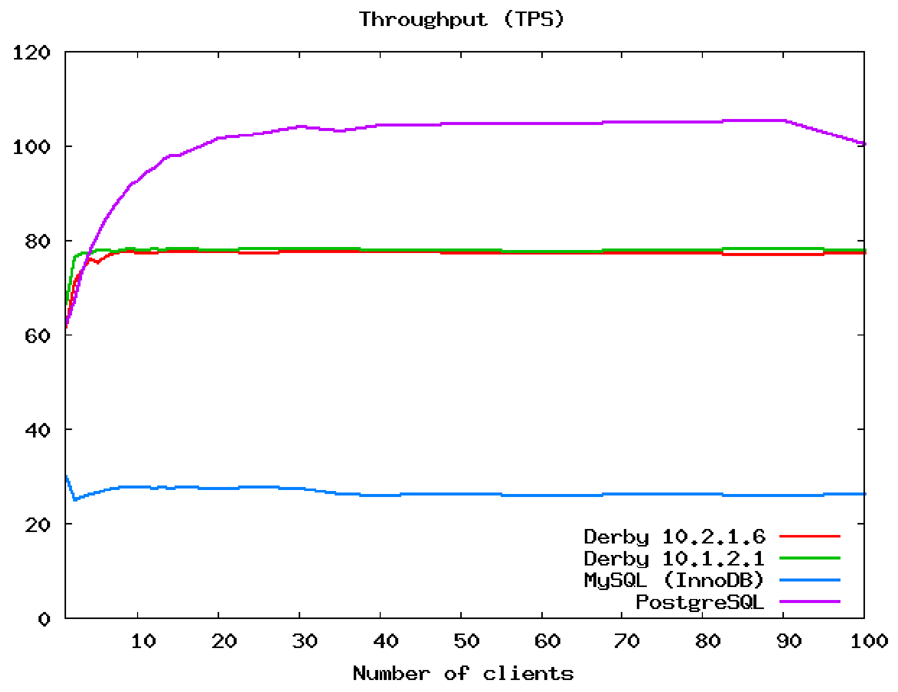

Performance Improvement Activities

General:

- SQL optimizer improvements

CPU usage:

- Improve use of synchronization to reduce lock contention
- Reduce object allocations/garbage collection

Client-Server:

- Improve LOB streaming

Disk IO:

- Allow concurrent read/write operations on data files
- Reduce number of disk updates during log write

Summary

Performance:

- Separate data and log on different disks
- Configure database buffer to keep most used data
- Use indexes
- Use the Derby tools:
  - query plan
  - optimizer overrides
  - timing statistics

Durability:

- Write log to two disks
  - write cache on disk is dangerous
- Backup regularly
  - include archive log
- Have a strategy for backup and recovery
  - TEST IT!!

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