

Department of Computer Science
Heterogenous Information Systems Group

Master's Thesis:

Bottlenecks Uncovered: A Component-Wise Breakdown of the Runtime of an OLTP System

by **Max Fabian Gilbert***

Day of Issue: February 1, 2020
Day of Release: June 1, 2020

Advisor: M. Sc. Caetano Sauer
First Reviewer: Prof. Dr.-Ing. Stefan Deßloch
Second Reviewer: Prof. Dr.-Ing. Dr. h. c. Theo Härder

Abstract

This page intentionally left blank.

Contents

1	Buffer Pool Pointer Swizzling	1
1.1	Introduction	1
1.2	Performance Evaluation	1
1.2.1	System Configuration	1
1.2.2	Benchmark	1
1.2.3	Results	1
1.2.4	Analysis	1
1.3	Conclusion	1
2	Buffer Pool Page Eviction Manager	2
2.1	Introduction	3
2.2	Page Eviction Strategies	3
2.2.1	RANDOM	3
2.2.1.1	LOOP	3
2.2.2	FIFO	3
2.2.3	FILO	3
2.2.4	LRU	3
2.2.4.1	Hash-Map-Linked-List Implementation	3
2.2.4.2	Timestamp-Sorting Implementation	3
2.2.5	MRU	3
2.2.6	LRU-K	3
2.2.6.1	Hash-Map-Linked-List Implementation	3
2.2.6.2	Timestamp-Sorting Implementation	3
2.2.7	SLRU	3
2.2.8	CLOCK	3
2.2.9	GCLOCK	3
2.2.9.1	GCLOCK-V1	3
2.2.9.2	GCLOCK-V2	3

2.2.10	DGCLOCK	3
2.2.10.1	DGCLOCK-V1	3
2.2.10.2	DGCLOCK-V2	3
2.2.11	LRD	3
2.2.11.1	LRD-V1	3
2.2.11.2	LRD-V2	3
2.2.12	LFU	3
2.2.13	LFUDA	3
2.2.14	MQ	3
2.2.15	ARC	3
2.2.16	CAR	3
2.2.16.1	CART	3
2.2.17	LIRS	3
2.2.18	CLOCK-Pro	3
2.2.19	LeanStore	3
2.3	Performance Evaluation	3
2.3.1	System Configuration	3
2.3.2	Benchmark	3
2.3.3	Results	3
2.3.4	Analysis	3
2.4	Conclusion	3
3	Component-Wise Performance Evaluation of an OLTP System	4
3.1	Introduction	4
3.2	Single-Threaded OLTP System Analysis	4
3.2.1	Read-Only YCSB	4
3.2.2	Write-Only YCSB	4
3.2.3	Read-Write YCSB	4
3.2.4	TPC-B	4
3.2.5	TPC-C	4
3.3	Multi-Threaded OLTP System Analysis	4
3.3.1	Read-Only YCSB	4
3.3.2	Write-Only YCSB	4
3.3.3	Read-Write YCSB	4
3.3.4	TPC-B	4

Contents

3.3.5	TPC-C	4
3.4	Conclusion	4

List of Figures

List of Tables

List of Algorithms

List of Listings

This page intentionally left blank.

1 Buffer Pool Pointer Swizzling

1.1 Introduction

1.2 Performance Evaluation

1.2.1 System Configuration

1.2.2 Benchmark

1.2.3 Results

1.2.4 Analysis

1.3 Conclusion

2 Buffer Pool Page Eviction Manager

2.1 Introduction

2.2 Page Eviction Strategies

2.2.1 RANDOM Replacement

2.2.1.1 LOOP Replacement

2.2.2 First In, First Out (FIFO)

2.2.3 First In, Last Out (FILO)

2.2.4 Least Recently Used (LRU)

2.2.4.1 Hash-Map-Linked-List Implementation

2.2.4.2 Timestamp-Sorting Implementation

2.2.5 Most Recently Used (MRU)

2.2.6 LRU-K

2.2.6.1 Hash-Map-Linked-List Implementation

2.2.6.2 Timestamp-Sorting Implementation

2.2.7 Segmented LRU (SLRU)

2.2.8 CLOCK

2.2.9 Generalized CLOCK (GCLOCK)

2.2.9.1 GCLOCK-V1

2.2.9.2 GCLOCK-V2

2.2.10 Dynamic Generalized CLOCK (DGCLOCK)

2.2.10.1 DGCLOCK-V1

2.2.10.2 DGCLOCK-V2

2.2.11 Least Reference Density (LRD)

2.2.11.1 LRD-V1₃

2.2.11.2 LRD-V2

2.2.12 Least Frequently Used (LFU)

2.2.13 LFU With Dynamic Aging (LFUDA)

2.2.14 Multi Queue (MQ)

2.2.15 Adaptive Replacement Cache (ARC)

2.2.16 Clock With Adaptive Replacement (CAR)

2.2.16.1 CAR With Temporal Filtering (CART)

2.2.17 Low Inter-Reference Recency Set (LIRS)

2.2.18 CLOCK-Pro

3 Component-Wise Performance Evaluation of an OLTP System

3.1 Introduction

3.2 Single-Threaded OLTP System Analysis

3.2.1 Read-Only YCSB

3.2.2 Write-Only YCSB

3.2.3 Read-Write YCSB

3.2.4 TPC-B

3.2.5 TPC-C

3.3 Multi-Threaded OLTP System Analysis

3.3.1 Read-Only YCSB

3.3.2 Write-Only YCSB

3.3.3 Read-Write YCSB

3.3.4 TPC-B

3.3.5 TPC-C

3.4 Conclusion