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Michael Jaedicke

New Concepts for Parallel Object-Relational Query Processing



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Preface

When I started this research, no commercial database system supported both object-relational features and parallelism. In the meantime this situation has changed dramatically. All major vendors now offer a parallel, object-relational DBMS as their high-end product. However, there is still a lot to do. Firstly, object-relational (or extensible) DBMS have yet to mature fully. Secondly, the integration of parallelism and extensibility has not yet been completed. This work is my attempt to make a contribution to both issues.

Some of the concepts and techniques developed have been implemented in a prototypical parallel database system called MIDAS. This system is the result of a team effort to which many people have contributed. My own contributions to the system are the user-defined functions and user-defined table operators, the extension of the system tables for those user-defined objects and for detailed statistics, and the new query optimizer, for which I worked with Clara Nippl. She contributed especially to the cost model, the physical operators, and implementation rules. Furthermore, I provided support for the development of concepts for the query parallelizer, the query execution control system, and the send/receive operators of the execution system.

Acknowledgments

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I am very grateful to Prof. Dr.-Ing. Theo Härder who introduced me thoroughly to database systems and taught me a lot about engineering. I am also grateful to him for the analysis of my results and his valuable remarks.

I also acknowledge the help of my colleagues Giannis Bozas, Clara Nippl, Angelika Reiser, and Stephan Zimmermann with whom I worked together on the MIDAS project. Stephan provided software engineering support for the whole group and was always helpful. His work centered on PVM communication, the process architecture, buffer and transaction management, the parallelization of the execution system, the

scheduler and benchmarking, and performance. Clara worked on the parallelization of the execution system, the scheduler, the parallelizer, and the optimizer. Giannis focussed on the lock manager and the buffer management. I also thank Prof. Rudolf Bayer, who led the project together with Prof. Mitschang, for his support.

I also enjoyed giving practical courses on RDBMS together with Angelika. I thank all my colleagues in Munich and Stuttgart, especially Aiko Frank, Volker Markl, Jürgen Sellentin, and Martin Zirkel for their help and comradeship during the last years. I am grateful to my colleague Ralf Rantzau and to Prof. Härder for improving my English.

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I also gratefully acknowledge the valuable comments of the anonymous referees of diverse papers, which have also improved this work. The feedback from C. Mohan, G. Lohman, and M. Carey on the issue of interfaces for query execution plans and the feedback from Harald Schöning on the parallel execution of user-defined functions is much appreciated.

Finally, I would like to thank the Deutsche Forschungsgemeinschaft (DFG) for funding the MIDAS project (SFB 342, B2). I also acknowledge the support of the Studienstiftung des Deutschen Volkes during my university course.

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Last but not least I am grateful to my parents for their affection and continuous care.

July 2001

Michael Jaedicke

Abstract

During the last few years parallel object-relational database management systems have emerged as the leading data management technology on the market place. These systems are extensible by user-defined data types and user-defined functionality for the data. This work focuses on the efficient parallel execution of user-defined functionality. The main contributions describe techniques to support data parallelism for user-defined scalar and aggregate functions, to support intra-function parallelism for the execution of a scalar function on a large object, and a new technology to provide extensibility with regard to new set-oriented database operations that can efficiently implement user-defined functionality in parallel object-relational database management systems. Some of these techniques have been implemented in the MIDAS prototype or on top of a commercial object-relational database management system.

Table of Contents

CHAPTER 1 *Introduction*

1.1	ORDBMS: The Next Great Wave	1
1.2	Extensible DBMS	2
1.3	Overview	3

CHAPTER 2 *Background on User-Defined Routines*

2.1	User-Defined Routines	5
2.2	Definition, Implementation, and Execution of New UDR	6
2.2.1	User-Defined Scalar Functions	7
2.2.2	User-Defined Aggregate Functions	9
2.2.3	User-Defined Table Functions	10
2.2.4	User-Defined Functions and Large Objects	11
2.3	Comparison with Stored Procedures	12
2.4	Optimization of Queries with UDF	12

CHAPTER 3 *Parallel Processing of User-Defined Functions*

3.1	Introduction	14
3.2	Limits of Current ORDBMS	15
3.3	Parallel Processing of UDF	17
3.3.1	Two Step Parallel Aggregation of UDAF	17
3.3.2	Partitioning Classes and Partitionable Functions	18
3.3.3	Parallel Sorting as a Preprocessing Step for UDAF	21
3.3.4	Extended Syntax for Function Registration	22
3.4	Example Applications	24
3.4.1	The UDAF Most_Frequent	24
3.4.2	The UDSF Running_Average	25
3.4.3	The UDAF Median	25
3.4.4	Further Applications	26
3.5	Plausibility Considerations Regarding Performance	28
3.6	Related Work	30
3.7	Summary	31

CHAPTER 4 *Intra-function Parallelism*

4.1	Introduction	33
4.2	Compose/Decompose Operators for Intra-function Parallelism	34
4.2.1	Compose/Decompose Operators	34
4.2.2	Extensibility of Compose Operators by Combine Functions	36
4.2.3	Application of Intra-function Parallelism	37
4.2.4	Intra-function Parallelism for Function Pipelines	38
4.3	Experimental Performance Study	39
4.3.1	Experimental Scenario and Implementation	39
4.3.2	Performance Results	41
4.4	Related Work	43
4.5	Summary	44

CHAPTER 5 *The Multi-operator Method*

5.1 Introduction 45

5.2 Performance Problems with Complex UDF in Current ORDBMS 46

5.2.1 The PBSM Algorithm as a Sophisticated UDP Implementation 47

5.3 The Multi-operator Method as a New Technique to Implement Complex UDF 49

5.3.1 The Multi-operator Method and Its Benefits 49

5.3.2 A Multi-operator Implementation of the PBSM Algorithm 51

5.4 Supporting the Multi-operator Method 53

5.4.1 Executing Query Execution Plans 53

5.4.2 Example for a Textual Specification of Query Execution Plans 55

5.4.3 Parallel Evaluation 55

5.5 Performance Evaluation 56

5.5.1 Experimental Scenario 56

5.5.2 Performance Results 62

5.6 Related Work 64

5.7 Summary 65

CHAPTER 6 *User-Defined Table Operators*

6.1 Introduction 67

6.2 User-Defined Table Operators 68

6.2.1 A Generalization Relationship for Row Types 68

6.2.2 Defining and Implementing UDTO 69

6.2.3 The Different Usages of the UDTO Concept 74

6.2.4 Parallel Processing of Procedural UDTO 77

6.2.5 Extension to Multiple Output Tables 80

6.3 Example Applications for UDTO 81

6.3.1 Computing a Spatial Join 81

6.3.2 Different UDTO for the Same Predicate 85

6.3.3 Computing the Median: An Aggregation Operator 89

6.3.4 A UDTO for a Complex Aggregation 90

6.3.5 Association Rule Mining 94

6.4 Related Work 101

6.5 Summary and Conclusions 102

CHAPTER 7 *Implementation of UDTO*

7.1 Introduction 106

7.2 The MIDAS Prototype 106

7.2.1 Architectural Overview 107

7.2.2 Query Compilation and Execution 108

7.2.3 The MIDAS System Tables 111

7.2.4 UDSF in MIDAS 112

7.3 Implementation of SQL Macros 113

7.3.1 DDL Statements 113

7.3.2 SQL Macro Expansion in DML Statements 115

7.3.3 Expanding SQL Macros in Preprocessors and Middleware 116

7.4	Implementation of Procedural UDTO	123
7.4.1	Extensions to the SQL Compiler	123
7.4.2	Extensions to the Optimizer and the Parallelizer	125
7.4.3	Extensions to the Scheduler	126
7.4.4	Extensions to the Execution Engine	126
7.4.5	Extensions to Transaction Management	128
7.4.6	Implementation of Input and Output Tables	131
7.5	Optimization Issues for UDTO	134
7.5.1	UDTO and Implied Predicates	134
7.5.2	Estimating Costs and Selectivity of UDTO	135
7.5.3	Application of Traditional Optimization Rules	137
7.6	Using UDTO to Generate Alternative Execution Plans for UDF	138
7.7	Evaluation of the Implementation	139
7.7.1	Evaluation of SQL Macros	140
7.7.2	Evaluation of Procedural UDTO	142
7.8	Summary	144

CHAPTER 8 Summary, Conclusions, and Future Work

8.1	Summary	145
8.2	Conclusions	146
8.3	Future Work	149

References

References	151
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Appendix A

A.1	The Program <code>sequential_invert</code>	157
A.2	The Program <code>parallel_invert</code>	158
A.3	The Query Execution Plan for the Spatial Join with SQL Macro	159