

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Distributed Data Processing	2
1.2	What is a Distributed Database System?	3
1.3	Data Delivery Alternatives	5
1.4	Promises of DDBSs	7
1.4.1	Transparent Management of Distributed and Replicated Data	7
1.4.2	Reliability Through Distributed Transactions	12
1.4.3	Improved Performance	14
1.4.4	Easier System Expansion	15
1.5	Complications Introduced by Distribution	16
1.6	Design Issues	16
1.6.1	Distributed Database Design	17
1.6.2	Distributed Directory Management	17
1.6.3	Distributed Query Processing	17
1.6.4	Distributed Concurrency Control	18
1.6.5	Distributed Deadlock Management	18
1.6.6	Reliability of Distributed DBMS	18
1.6.7	Replication	19
1.6.8	Relationship among Problems	19
1.6.9	Additional Issues	20
1.7	Distributed DBMS Architecture	21
1.7.1	ANSI/SPARC Architecture	21
1.7.2	A Generic Centralized DBMS Architecture	23
1.7.3	Architectural Models for Distributed DBMSs	25
1.7.4	Autonomy	25
1.7.5	Distribution	27
1.7.6	Heterogeneity	27
1.7.7	Architectural Alternatives	28
1.7.8	Client/Server Systems	28
1.7.9	Peer-to-Peer Systems	32
1.7.10	Multidatabase System Architecture	35

1.8	Bibliographic Notes .....	38
<b>2</b>	<b>Background .....</b>	<b>41</b>
2.1	Overview of Relational DBMS .....	41
2.1.1	Relational Database Concepts .....	41
2.1.2	Normalization .....	43
2.1.3	Relational Data Languages .....	45
2.2	Review of Computer Networks .....	58
2.2.1	Types of Networks .....	60
2.2.2	Communication Schemes .....	63
2.2.3	Data Communication Concepts .....	65
2.2.4	Communication Protocols .....	67
2.3	Bibliographic Notes .....	70
<b>3</b>	<b>Distributed Database Design .....</b>	<b>71</b>
3.1	Top-Down Design Process .....	73
3.2	Distribution Design Issues .....	75
3.2.1	Reasons for Fragmentation .....	75
3.2.2	Fragmentation Alternatives .....	76
3.2.3	Degree of Fragmentation .....	77
3.2.4	Correctness Rules of Fragmentation .....	79
3.2.5	Allocation Alternatives .....	79
3.2.6	Information Requirements .....	80
3.3	Fragmentation .....	81
3.3.1	Horizontal Fragmentation .....	81
3.3.2	Vertical Fragmentation .....	98
3.3.3	Hybrid Fragmentation .....	112
3.4	Allocation .....	113
3.4.1	Allocation Problem .....	114
3.4.2	Information Requirements .....	116
3.4.3	Allocation Model .....	118
3.4.4	Solution Methods .....	121
3.5	Data Directory .....	122
3.6	Conclusion .....	123
3.7	Bibliographic Notes .....	125
<b>4</b>	<b>Database Integration .....</b>	<b>131</b>
4.1	Bottom-Up Design Methodology .....	133
4.2	Schema Matching .....	137
4.2.1	Schema Heterogeneity .....	140
4.2.2	Linguistic Matching Approaches .....	141
4.2.3	Constraint-based Matching Approaches .....	143
4.2.4	Learning-based Matching .....	145
4.2.5	Combined Matching Approaches .....	146
4.3	Schema Integration .....	147

4.4	Schema Mapping	149
4.4.1	Mapping Creation	150
4.4.2	Mapping Maintenance	155
4.5	Data Cleaning	157
4.6	Conclusion	159
4.7	Bibliographic Notes	160
<b>5</b>	<b>Data and Access Control</b>	<b>171</b>
5.1	View Management	172
5.1.1	Views in Centralized DBMSs	172
5.1.2	Views in Distributed DBMSs	175
5.1.3	Maintenance of Materialized Views	177
5.2	Data Security	180
5.2.1	Discretionary Access Control	181
5.2.2	Multilevel Access Control	183
5.2.3	Distributed Access Control	185
5.3	Semantic Integrity Control	187
5.3.1	Centralized Semantic Integrity Control	189
5.3.2	Distributed Semantic Integrity Control	194
5.4	Conclusion	200
5.5	Bibliographic Notes	201
<b>6</b>	<b>Overview of Query Processing</b>	<b>205</b>
6.1	Query Processing Problem	206
6.2	Objectives of Query Processing	209
6.3	Complexity of Relational Algebra Operations	210
6.4	Characterization of Query Processors	211
6.4.1	Languages	212
6.4.2	Types of Optimization	212
6.4.3	Optimization Timing	213
6.4.4	Statistics	213
6.4.5	Decision Sites	214
6.4.6	Exploitation of the Network Topology	214
6.4.7	Exploitation of Replicated Fragments	215
6.4.8	Use of Semijoins	215
6.5	Layers of Query Processing	215
6.5.1	Query Decomposition	216
6.5.2	Data Localization	217
6.5.3	Global Query Optimization	218
6.5.4	Distributed Query Execution	219
6.6	Conclusion	219
6.7	Bibliographic Notes	220

<b>7</b>	<b>Query Decomposition and Data Localization</b>	221
7.1	Query Decomposition	222
7.1.1	Normalization	222
7.1.2	Analysis	223
7.1.3	Elimination of Redundancy	226
7.1.4	Rewriting	227
7.2	Localization of Distributed Data	231
7.2.1	Reduction for Primary Horizontal Fragmentation	232
7.2.2	Reduction for Vertical Fragmentation	235
7.2.3	Reduction for Derived Fragmentation	237
7.2.4	Reduction for Hybrid Fragmentation	238
7.3	Conclusion	241
7.4	Bibliographic NOTES	241
<b>8</b>	<b>Optimization of Distributed Queries</b>	245
8.1	Query Optimization	246
8.1.1	Search Space	246
8.1.2	Search Strategy	248
8.1.3	Distributed Cost Model	249
8.2	Centralized Query Optimization	257
8.2.1	Dynamic Query Optimization	257
8.2.2	Static Query Optimization	261
8.2.3	Hybrid Query Optimization	265
8.3	Join Ordering in Distributed Queries	267
8.3.1	Join Ordering	267
8.3.2	Semijoin Based Algorithms	269
8.3.3	Join versus Semijoin	272
8.4	Distributed Query Optimization	273
8.4.1	Dynamic Approach	274
8.4.2	Static Approach	277
8.4.3	Semijoin-based Approach	281
8.4.4	Hybrid Approach	286
8.5	Conclusion	290
8.6	Bibliographic Notes	292
<b>9</b>	<b>Multidatabase Query Processing</b>	297
9.1	Issues in Multidatabase Query Processing	298
9.2	Multidatabase Query Processing Architecture	299
9.3	Query Rewriting Using Views	301
9.3.1	Datalog Terminology	301
9.3.2	Rewriting in GAV	302
9.3.3	Rewriting in LAV	304
9.4	Query Optimization and Execution	307
9.4.1	Heterogeneous Cost Modeling	307
9.4.2	Heterogeneous Query Optimization	314

9.4.3	Adaptive Query Processing	320
9.5	Query Translation and Execution	327
9.6	Conclusion	330
9.7	Bibliographic Notes	331
<b>10</b>	<b>Introduction to Transaction Management</b>	<b>335</b>
10.1	Definition of a Transaction	337
10.1.1	Termination Conditions of Transactions	339
10.1.2	Characterization of Transactions	340
10.1.3	Formalization of the Transaction Concept	341
10.2	Properties of Transactions	344
10.2.1	Atomicity	344
10.2.2	Consistency	345
10.2.3	Isolation	346
10.2.4	Durability	349
10.3	Types of Transactions	349
10.3.1	Flat Transactions	351
10.3.2	Nested Transactions	352
10.3.3	Workflows	353
10.4	Architecture Revisited	356
10.5	Conclusion	357
10.6	Bibliographic Notes	358
<b>11</b>	<b>Distributed Concurrency Control</b>	<b>361</b>
11.1	Serializability Theory	362
11.2	Taxonomy of Concurrency Control Mechanisms	367
11.3	Locking-Based Concurrency Control Algorithms	369
11.3.1	Centralized 2PL	373
11.3.2	Distributed 2PL	374
11.4	Timestamp-Based Concurrency Control Algorithms	377
11.4.1	Basic TO Algorithm	378
11.4.2	Conservative TO Algorithm	381
11.4.3	Multiversion TO Algorithm	383
11.5	Optimistic Concurrency Control Algorithms	384
11.6	Deadlock Management	387
11.6.1	Deadlock Prevention	389
11.6.2	Deadlock Avoidance	390
11.6.3	Deadlock Detection and Resolution	391
11.7	“Relaxed” Concurrency Control	394
11.7.1	Non-Serializable Histories	395
11.7.2	Nested Distributed Transactions	396
11.8	Conclusion	398
11.9	Bibliographic Notes	401

<b>12 Distributed DBMS Reliability</b>	405
12.1 Reliability Concepts and Measures	406
12.1.1 System, State, and Failure	406
12.1.2 Reliability and Availability	408
12.1.3 Mean Time between Failures/Mean Time to Repair	409
12.2 Failures in Distributed DBMS	410
12.2.1 Transaction Failures	411
12.2.2 Site (System) Failures	411
12.2.3 Media Failures	412
12.2.4 Communication Failures	412
12.3 Local Reliability Protocols	413
12.3.1 Architectural Considerations	413
12.3.2 Recovery Information	416
12.3.3 Execution of LRM Commands	420
12.3.4 Checkpointing	425
12.3.5 Handling Media Failures	426
12.4 Distributed Reliability Protocols	427
12.4.1 Components of Distributed Reliability Protocols	428
12.4.2 Two-Phase Commit Protocol	428
12.4.3 Variations of 2PC	434
12.5 Dealing with Site Failures	436
12.5.1 Termination and Recovery Protocols for 2PC	437
12.5.2 Three-Phase Commit Protocol	443
12.6 Network Partitioning	448
12.6.1 Centralized Protocols	450
12.6.2 Voting-based Protocols	450
12.7 Architectural Considerations	453
12.8 Conclusion	454
12.9 Bibliographic Notes	455
<b>13 Data Replication</b>	459
13.1 Consistency of Replicated Databases	461
13.1.1 Mutual Consistency	461
13.1.2 Mutual Consistency versus Transaction Consistency	463
13.2 Update Management Strategies	465
13.2.1 Eager Update Propagation	465
13.2.2 Lazy Update Propagation	466
13.2.3 Centralized Techniques	466
13.2.4 Distributed Techniques	467
13.3 Replication Protocols	468
13.3.1 Eager Centralized Protocols	468
13.3.2 Eager Distributed Protocols	474
13.3.3 Lazy Centralized Protocols	475
13.3.4 Lazy Distributed Protocols	480
13.4 Group Communication	482

13.5	Replication and Failures	485
13.5.1	Failures and Lazy Replication	485
13.5.2	Failures and Eager Replication	486
13.6	Replication Mediator Service	489
13.7	Conclusion	491
13.8	Bibliographic Notes	493
<b>14</b>	<b>Parallel Database Systems</b>	<b>497</b>
14.1	Parallel Database System Architectures	498
14.1.1	Objectives	498
14.1.2	Functional Architecture	501
14.1.3	Parallel DBMS Architectures	502
14.2	Parallel Data Placement	508
14.3	Parallel Query Processing	512
14.3.1	Query Parallelism	513
14.3.2	Parallel Algorithms for Data Processing	515
14.3.3	Parallel Query Optimization	521
14.4	Load Balancing	525
14.4.1	Parallel Execution Problems	525
14.4.2	Intra-Operator Load Balancing	527
14.4.3	Inter-Operator Load Balancing	529
14.4.4	Intra-Query Load Balancing	530
14.5	Database Clusters	534
14.5.1	Database Cluster Architecture	535
14.5.2	Replication	537
14.5.3	Load Balancing	540
14.5.4	Query Processing	542
14.5.5	Fault-tolerance	545
14.6	Conclusion	546
14.7	Bibliographic Notes	547
<b>15</b>	<b>Distributed Object Database Management</b>	<b>551</b>
15.1	Fundamental Object Concepts and Object Models	553
15.1.1	Object	553
15.1.2	Types and Classes	556
15.1.3	Composition (Aggregation)	557
15.1.4	Subclassing and Inheritance	558
15.2	Object Distribution Design	560
15.2.1	Horizontal Class Partitioning	561
15.2.2	Vertical Class Partitioning	563
15.2.3	Path Partitioning	563
15.2.4	Class Partitioning Algorithms	564
15.2.5	Allocation	565
15.2.6	Replication	565
15.3	Architectural Issues	566

15.3.1	Alternative Client/Server Architectures	567
15.3.2	Cache Consistency	572
15.4	Object Management	574
15.4.1	Object Identifier Management	574
15.4.2	Pointer Swizzling	576
15.4.3	Object Migration	577
15.5	Distributed Object Storage	578
15.6	Object Query Processing	582
15.6.1	Object Query Processor Architectures	583
15.6.2	Query Processing Issues	584
15.6.3	Query Execution	589
15.7	Transaction Management	593
15.7.1	Correctness Criteria	594
15.7.2	Transaction Models and Object Structures	596
15.7.3	Transactions Management in Object DBMSs	596
15.7.4	Transactions as Objects	605
15.8	Conclusion	606
15.9	Bibliographic Notes	607
<b>16</b>	<b>Peer-to-Peer Data Management</b>	<b>611</b>
16.1	Infrastructure	614
16.1.1	Unstructured P2P Networks	615
16.1.2	Structured P2P Networks	618
16.1.3	Super-peer P2P Networks	622
16.1.4	Comparison of P2P Networks	624
16.2	Schema Mapping in P2P Systems	624
16.2.1	Pairwise Schema Mapping	625
16.2.2	Mapping based on Machine Learning Techniques	626
16.2.3	Common Agreement Mapping	626
16.2.4	Schema Mapping using IR Techniques	627
16.3	Querying Over P2P Systems	628
16.3.1	Top-k Queries	628
16.3.2	Join Queries	640
16.3.3	Range Queries	642
16.4	Replica Consistency	645
16.4.1	Basic Support in DHTs	646
16.4.2	Data Currency in DHTs	648
16.4.3	Replica Reconciliation	649
16.5	Conclusion	653
16.6	Bibliographic Notes	653
<b>17</b>	<b>Web Data Management</b>	<b>657</b>
17.1	Web Graph Management	658
17.1.1	Compressing Web Graphs	660
17.1.2	Storing Web Graphs as S-Nodes	661



17.2	Web Search .....	663
17.2.1	Web Crawling .....	664
17.2.2	Indexing .....	667
17.2.3	Ranking and Link Analysis .....	668
17.2.4	Evaluation of Keyword Search .....	669
17.3	Web Querying .....	670
17.3.1	Semistructured Data Approach .....	671
17.3.2	Web Query Language Approach .....	676
17.3.3	Question Answering .....	681
17.3.4	Searching and Querying the Hidden Web .....	685
17.4	Distributed XML Processing .....	689
17.4.1	Overview of XML .....	691
17.4.2	XML Query Processing Techniques .....	699
17.4.3	Fragmenting XML Data .....	703
17.4.4	Optimizing Distributed XML Processing .....	710
17.5	Conclusion .....	718
17.6	Bibliographic Notes .....	719
<b>18</b>	<b>Current Issues: Streaming Data and Cloud Computing .....</b>	<b>723</b>
18.1	Data Stream Management .....	723
18.1.1	Stream Data Models .....	725
18.1.2	Stream Query Languages .....	727
18.1.3	Streaming Operators and their Implementation .....	732
18.1.4	Query Processing .....	734
18.1.5	DSMS Query Optimization .....	738
18.1.6	Load Shedding and Approximation .....	739
18.1.7	Multi-Query Optimization .....	740
18.1.8	Stream Mining .....	741
18.2	Cloud Data Management .....	744
18.2.1	Taxonomy of Clouds .....	745
18.2.2	Grid Computing .....	748
18.2.3	Cloud architectures .....	751
18.2.4	Data management in the cloud .....	753
18.3	Conclusion .....	760
18.4	Bibliographic Notes .....	762
	<b>References .....</b>	<b>765</b>
	<b>Index .....</b>	<b>833</b>



<http://www.springer.com/978-1-4419-8833-1>

Principles of Distributed Database Systems

Özsu, M.T.; Valduriez, P.

2011, XX, 846 p., Hardcover

ISBN: 978-1-4419-8833-1