Datenbanksysteme II: Implementation of Database Systems

Ulf Leser

Material von
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Prof. Alfons Kemper, Dr. Eickler
• I apologize for Denglish
My first contact with database

• Father: “I need to track my customers”
  - Name, address, profession, prior contracts

• Little Ulf: “No problem”
  - ~1984: Turbo Pascal 4.0, Schneider CPC646, 512 KB main memory
  - Load customers from disk into memory
  - Repeat until “Q”
    • (E)dit customer
    • (D)elete customer
    • (I)nsert customer
    • (Q)uit
  - Write customers to disk
  - Bill: 250.- DM
Story part 2

• Father: “I need to track my offers”
  - Customers have projects and call for bids, father makes offers
  - Many customers have many projects over time

• Little Ulf: “No problem”
  - Clever plan – reuse “software architecture”
  - Load offers from disk into memory
  - Repeat until “Q”
    • (E)dit offer
    • (D)elete offer
    • (I)nsert offer
    • (Q)uit
  - Write offers to disk
  - My (winning) offer: 400.- DM
Part 3

• Desaster!
  - No dynamic arrays at this time
  - Max. 500 customers
  - Max. 40 offers
  - Max. 2 KB per offer
  - Gives 20.000 times 2.000 = 40 MEGABYTE!
    • App. size of hard disc
  - No way to load and hold all data at startup
  - Wrong architecture
Solution 1

• Repeat until “Q”
  – (E)dit offer
    • Open file
    • Read and write until record found
    • Read, edit, and write record
    • Read and write until EOF
  – (D)elete offer
    • ...
  – (I)nser offer
    • ...
  – (Q)uit

• Very slow
Solution 2

- Some one should take care of finding, loading, storing data for me

- Buy dBase IV
Lessons learned

• **Scalability** is an issue
  - Works fine for small datasets, breaks down for large datasets

• **Data is Information is Knowledge is essential**
  - If offers-file corrupted - father goes out of business
    • Which will affect me too

• When is comes to large volumes of data - get a database and a **good database programmer**

• **Think before you program**
  - Project 100% over budget (dBase IV license)
  - Project 300% over time (6 months instead of 2)
Today’s Database Systems

• Databases are essential part of an enterprise’s infrastructure
  - As important as OS
  - Long-running, expensive, essential investment
  - Holds the most important business asset: information

• Database administrator is a profession
  - Many good programmers, but few good database developers/administrators
  - Always one of the skills most demanded in industry

• RDMS became an often “invisible” piece of software
  - “So nützlich wie fließendes Wasser” (G. Weikum, MPI Saarbrücken)

• DBAs are very complex, though apparently simple to use

• Good DBAs need to understand their system
History

- Prior to relational databases
  - Network databases, hierarchical databases, COBOL
- “Three waves”
  - Relational databases since 1980th
  - Object-oriented databases early 1990th
  - XML databases early 2000th
- Few „big“ vendors survived
  - Oracle, IBM DB2, Microsoft SQL Server
- Some niche players
  - Open Source: MySQL, PostGresSQL, Ingres, SAP DB
  - Data Warehousing: Teradata, Tandem
  - Mobile databases: Sybase
Importance

- Databases are behind almost every non-trivial piece of software
  - Data needs to be stored
    - Disk access is the main performance bottleneck
    - Hence: Optimize disk access in the RDBMS
  - Data is manipulated from many clients
    - Concurrent access quickly screws up data
    - Hence: Synchronize data access through the RDBMS
  - Data is used by many applications with different requirements
    - No good to design app-specific optimal data structures
    - Hence: Use application independent languages
  - Systems crash
    - Crashes cannot be avoided
    - Hence: Secure most valuable asset in a centralized manner
Complexity

• A RDBMS is a very, very complex piece of software
  – Oracle installs from 5+ CDs
• One code base
  – Oracle9i Database Release 2 Documentation for Microsoft Windows
  – Oracle9i Database Release 2 Documentation for 64-bit Windows
  – Oracle9i Database Release 2 Documentation for Solaris Operating System (SPARC)
  – Oracle9i Database Release 2 Documentation for AIX-Based Systems
  – Oracle9i Database Release 2 Documentation for Compaq Tru64 UNIX
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  – Oracle9i Database Release 2 Documentation for IBM Power based Linux
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  – Oracle9i Database Release 2 Documentation for Fujitsu Siemens Computers BS2000/OSD
  – Oracle9i Database Release 2 Documentation for Stratus Continuum 600 and 1200 Series
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Much more than „SELECT ... FROM ... WHERE“

- Text, Multimedia, spatial data
- Object-relational features
- XML, XQuery, XPath
- Parallel and distributed databases; Cluster; GRID
- Uniform access or uniform storage
  - File system goes database
- Data Mining and Business Intelligence
- Backup & Recovery
  - Try to make your application fault tolerant …
- Security, Auditing
- **DBs are infrastructure for application server**
Database System – 2 Tier

Web / CGI
SQL

Application Programs
SQL

DBMS

Database 1

Database 2
3 Tier

Application Server
Upwards: OO Interface
Downwards: SQL

Servlets/
EJB

Presentation

Application logic
“Business processes”

“State”
Storage,
Backup & Recovery
Synchronization

DBMS

Database 1

Database 2

Upwards: SQL
Downwards: OO Interface
SAP R/3: Enterprise Resource Planning

ONE central database server
(Possibly clustered)

LAN

WAN (Internet)
Why Databases?

• Data is extremely valuable

• Many programs do different things with the same data
  – Centralize data management
  – Avoid (uncontrolled) data redundancy
  – App-independent data model
  – App-independent access methods
  – Centralize control of data integrity

• Many users operate concurrently on the same data
  – Avoid blocking and inconsistencies
  – Authorization and Authentication
  – Support transactions

• Amount of data grows and grows and grows - scalability
  – Clients working on the same copy
  – Central query optimization, caching, connection sharing, etc.
  – Controlled, automated replication

• Data must not disappear – fault tolerance
  – Centralize data replication for safety
  – Centralize backup & recovery
Scalability

Abbildung 6.3: Entwicklung der Laufzeiten im Vergleich zu anderen Algorithmen

Quelle: G. Witterstein, Dissertation, 2005
Making the difference

• Databases are **not**
  - self-administrating
  - self-adapting
  - self-developing
  - self-healing
• Work mostly in the background – no GUI or dialogs
• Good database programs require **intensive knowledge** about the why & what & how
  - Which index to use and where to place it?
  - Which synchronization level?
  - When use parallel servers?
  - Optimization possibilities?
  - Where to look if something goes wrong?
DBS2: Implementation of Database Systems

• Lecture 4SWS
  - Tuesday, 13 – 15 , RUD26, 1‘305
  - Thursday, 13 – 15 , RUD26, 1‘305
  - Not : 5.5.2005, 26.5.2005

• Contact
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Praktikum & Exams

• “Praktikum”
  - Presence & commitment are necessary
  - Implementation of file-/ buffer-/ index manager in C++
  - Two groups
    • Tuesday, 15-17, RUD 26, Room 1'308
    • Thursday, 15-17, RUD 26, Room 1'308
  - Starts next week, introduction this Thursday during lecture
  - Team:
    • Heiko Müller, Frank Huber, Jana Bauckmann, Chokri ben Necib

• Examination
  - 30 minutes, oral exam
  - Alternative: Klausur
  - Dates will be set mid-June
  - Requires Praktikumsschein
  - No changing between Prof. Freytag / me
Slides

- Slides are available before / shortly after the lecture
- Please send me any errors
- I apologize: Mixture between English / Deutsch
- Slides are
  - No script
  - No substitution for listening to the lecture
  - No substitution for reading a book
Contents

1. Introduction
2. Basics of RDBMS
3. Overview and Architecture of DBMS
4. Access Methods
5. Query Processing and Optimization
6. Transactions and Concurrency Control
7. Recovery Concepts and Methods
8. Distributed DBMS
9. (Data Warehouse and Data Mining)
Überblick

- Logdateien
- Indexe
- Datenbasis
- Datenwörterbuch

- Dateiverwaltung
- Mehrbenutzersynchronisierung
- Fehlerbehandlung

- Anwendung
- Interaktive Anfrage
- Präcompiler

- Fortgeschrittene Benutzer
- Anwendungs-Programmierer

- Datenbankmanager
- Schemaverwaltung

- DML-Compiler
- TXs, Recovery
- Query processing
- Access methods

- DBMS
- Anfragebearbeitung
- Datenbankadministratoren

- Frontend
  - Anwendung
  - Interaktive Anfrage
  - Präcompiler

- Backend
  - Datenbankmanager
  - Schemaverwaltung

- Logdateien
- Indexe
- Datenbasis
- Datenwörterbuch

Hintergrundspeicher
Events

- Microsoft, SQL Server 2005
- Hopefully
  - Microstrategy
  - Oracle
  - Teradata
- Coordinated with lecture on Data Warehousing
Literature

• Primary

• Other
    • Deutsche Übersetzung: „Grundlagen von Datenbanksystemen“, Pearson, 2002
  - J. Gray, A. Reuter: Transaction Processing, Morgan Kaufman, 1993
Datenbanken@Informatik

Einführung in Datenbanken (DBS I)
Halb kurs, WS
4 SWS VL + 2 SWS Übung

Informationsintegration
Halb kurs, WS
4 SWS VL + 2 SWS Übung

Informationssysteme
Crash kurs, WS
1 x 8 Stunden mit Übung

Datawarehousing
VL, 4 SWS, SoSe
Halb kurs 4+2

Molekularbiologische Datenbanken
Spezial-VL, SoSe
2 SWS VL + 2 SWS Übung

Implementierung von Datenbanken (DBS II)
Halb kurs, SoSe
4 SWS VL + 2 SWS Übung

Web-basierte Informationssysteme
Spezial-VL, WS
2 SWS

XML und Semantic Web
Halb kurs, WS
4 SWS VL + 2 SWS Übung

Voraussetzung

Spezialvorlesungen

Günstige, aber nicht notwendige Voraussetzung

Halb kurs
Wissensmanagement in der Bioinformatik

• Schwerpunkte
  – Management molekularbiologischer Daten
  – Datenintegration
  – Datenzentrierte Algorithmen der Bioinformatik
  – Text Mining

• Laufend möglich
  – Studienarbeiten
  – Diplomarbeiten
  – … oft in Kooperation mit Bioinformatikfirmen
  – … oft in Kooperation mit Bioinformatikinstituten
Stelle frei

- Studentische Hilfskraft
- 40 Stunden / Monat
- Thema
  - Datenintegration
  - Life Science Daten
  - Automatische Verfahren, große Datenmengen
  - Teamwork
  - JAVA, Oracle oder DB2, Datenbankkenntnisse
- Start: 1.5.2005, Laufzeit 12 Monate
- Bewerbung: Prof. Naumann
Fragen ?
Fragen meinerseits

- Diplominformatiker?
- Semester?
- Prüfung?
- DBS-I

- Warum DBS-II?