



Wonderware.
Historian

ORACLE

Database Systems

From the automation perspective

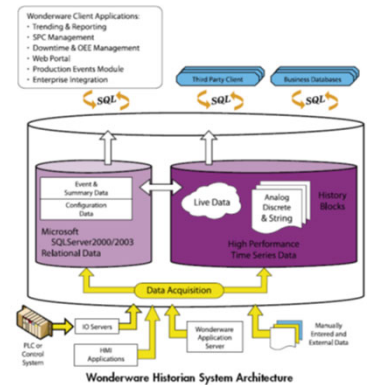



Microsoft
SQL Server 2012
Enterprise

MySQL

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What is the core of the factory?



Wonderware Client Applications:
 • Trending & Reporting
 • SPC Management
 • Downtime & OEE Management
 • Web Portal
 • Production Events Module
 • Enterprise Integration

Third Party Client Business Database

Event & Summary Data
 Configuration Data
 Microsoft SQL Server 2000/2003
 Relational Data

Live Data
 Analog Discrete & String
 High Performance Time Series Data
 History Blocks

Data Acquisition

PLC or Control System
 I/O Servers
 IBM Applications
 Wonderware Application Server
 Manually Entered and External Data

Wonderware Historian System Architecture

Picture from www.wonderware.com

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Overview

- Why use databases in automation?
- What is a database?
- SQL (Structured Query Language)
- What's special about industrial databases?
- Real products

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Goal

After this lecture you should:

- Know basic terms regarding DB
- Understand database schema basics
- Have some SQL knowledge
- **Have started to understand the complexity of the database problem in Automation**

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Why DB in Automation?

- Keep track of materials, machines and products
- Adjust production to meet incoming orders
- Send orders for materials and synchronize with subcontractors
- Quality control (ISO9000)
- Regulations (e.g. FDA - <http://www.fda.gov/>)

These are just a few examples...

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Information in the process

- Static data e.g.
 - Machine performance
 - CAD drawing
 - Other specifications
- Dynamic data e.g.
 - Orders, timelimits
 - Buffer quantities
 - Available resources

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The database (DB)

- Contains data
- Grouped data
- Describes a part of the world
- Data described by a schema
- Consistent contents
- Handled by a DBMS

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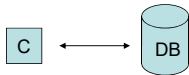
DBMS

- DataBase Management System
- Often referred to as "database system"
- Complex software systems
- Tasks
 - Storage
 - Programming interface (query processor)
 - Manage transaction

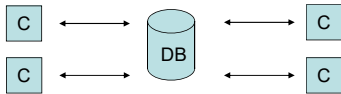
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Client –Server structures (1)

- One client – one server



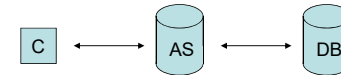
- Many clients – one server
– Realtime considerations



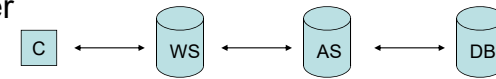
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Client –Server structures (2)

- Application server – DB server



- E.g. web server – application server – DB server



Put the heavy load as early as possible!

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Data Warehouse

(Datalager på svenska)

- Data from many DB needed
- Different locations, companies or structures.
- Legacy databases have to be included
- Copy and translate
- Update as original data is changed

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A database object

Usually a data structure (record, table) containing a number of attributes connected to a key element.

In automation: A motor, valve, measurement point, component type, product

This definition is crucial!

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References to Objects

- Hash tables
 - Complex data, transformed to simple key
 - Collision handling
- Indexes
 - B-tree (balanced tree)
 - Correlate to e.g. disk block size

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Indexes

- Can't search entire data to answer question
- Sequential file sorted on attribute - simple
- Dense/Sparse indexes tradeoff between space and speed
- Maintain index files when data is modified

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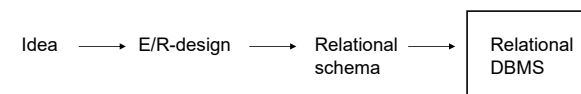
The Schema

- Data model describes possible schemas
- The schema describes what data can be stored
- Three levels
 - External : How the user sees it
 - Logical : implementation model (tables)
 - Internal/physical : actual storage

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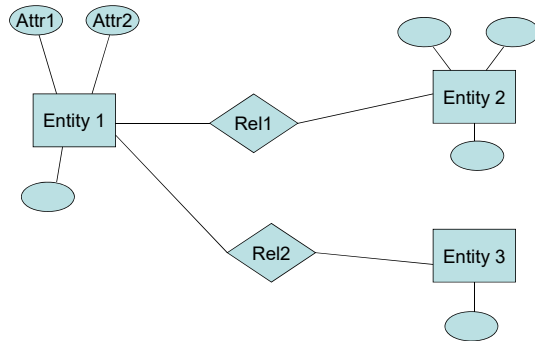
Entity-Relationship Model (1)

- Entity sets
- Attributes
- Relationships



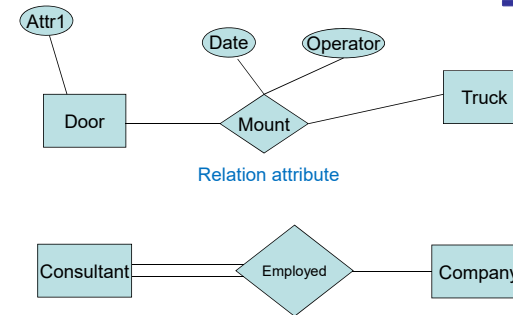
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Entity-Relationship Model (2)



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Entity-Relationship Model (3)



A consultant has to be employed by a company.
A company don't have to but can employ consultants.

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ER diagrams

- Often only on paper
- Many notations. "Chen" is common
- The conceptual ER notation is often translated to tables

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Other data models

- Relational models
 - Related key attribute becomes part of the schema. Relationship attributes are also included.
- Object oriented
 - C++, java with persistent data. E.g. ODL (Object definition Language)
 - Object relational, SQL-99
- Semistructured
 - XML (extensible markup language)

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SQL – Structured Query Language

- Both for queries and data manipulation
- Three standards
 - ANSI SQL
 - SQL-92 (SQL2)
 - SQL 1999 (SQL3)
 - SQL 2003

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Simple SQL Query

```
SELECT ...  
FROM ...  
WHERE ...
```

E.g.

```
SELECT *  
FROM Components  
WHERE Price>300
```

Operators: *, +, -, >, <, >=, <=, <>, || (concat)

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More SQL Reserved Words

- AS
 - E.g. `SELECT Units*Cost AS ValueOfStore`
- LIKE
 - E.g. `WHERE Supplier LIKE '%Inc%'`
- AND, OR, UNKNOWN, TRUE, FALSE
- ORDER BY

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Industrial DB

- Automated data generation
 - PLC, Controllers, IIoT
- High speed
- Many clients
- Wide range of complexity

A well designed schema and data condensation are needed

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Real products

- Microsoft SQL server, Industrial SQL serv.
- ORACLE
- MySQL (SUN-Oracle) <http://www.mysql.com/>
- ABB Industrial IT, Aspect Object Model
- Siemens SIMATIC Process Historian

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Conclusions

- DBMS are some of the most demanding programming tasks.
- DBMS in automation environments requires careful design. Experience needed!
- Well standardized interfaces and languages makes data extraction feasible.

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