Welcome to course

COMP810: Data Warehousing and Big Data

Outlines

- Course information
- Teaching team
- Learning outcomes
- Course contents and schedule
- Assessments
- Resources
- Lecture 01

Course Information

Course Title:	Data Warehousing and Big Data
Course Code:	COMP810
Prerequisites:	None
Co-requisites:	None
Level:	8

Teaching Team

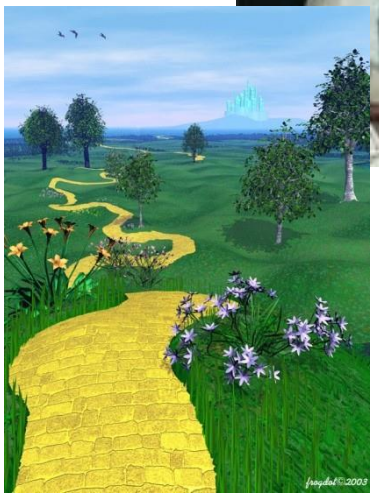
- **Dr Muhammad Asif Naeem**
  Lecturer
  Email: mnaeem@aut.ac.nz
  Office: WT134
  Ext: 5083
- **Ali Haider Hussein Ghazala**
  TA
  Email : ahaiderh@aut.ac.nz

Why should you be here?

- Bad decisions can lead to disaster
  - Data Warehousing is at the **base of decision support systems**

Why should you be here?

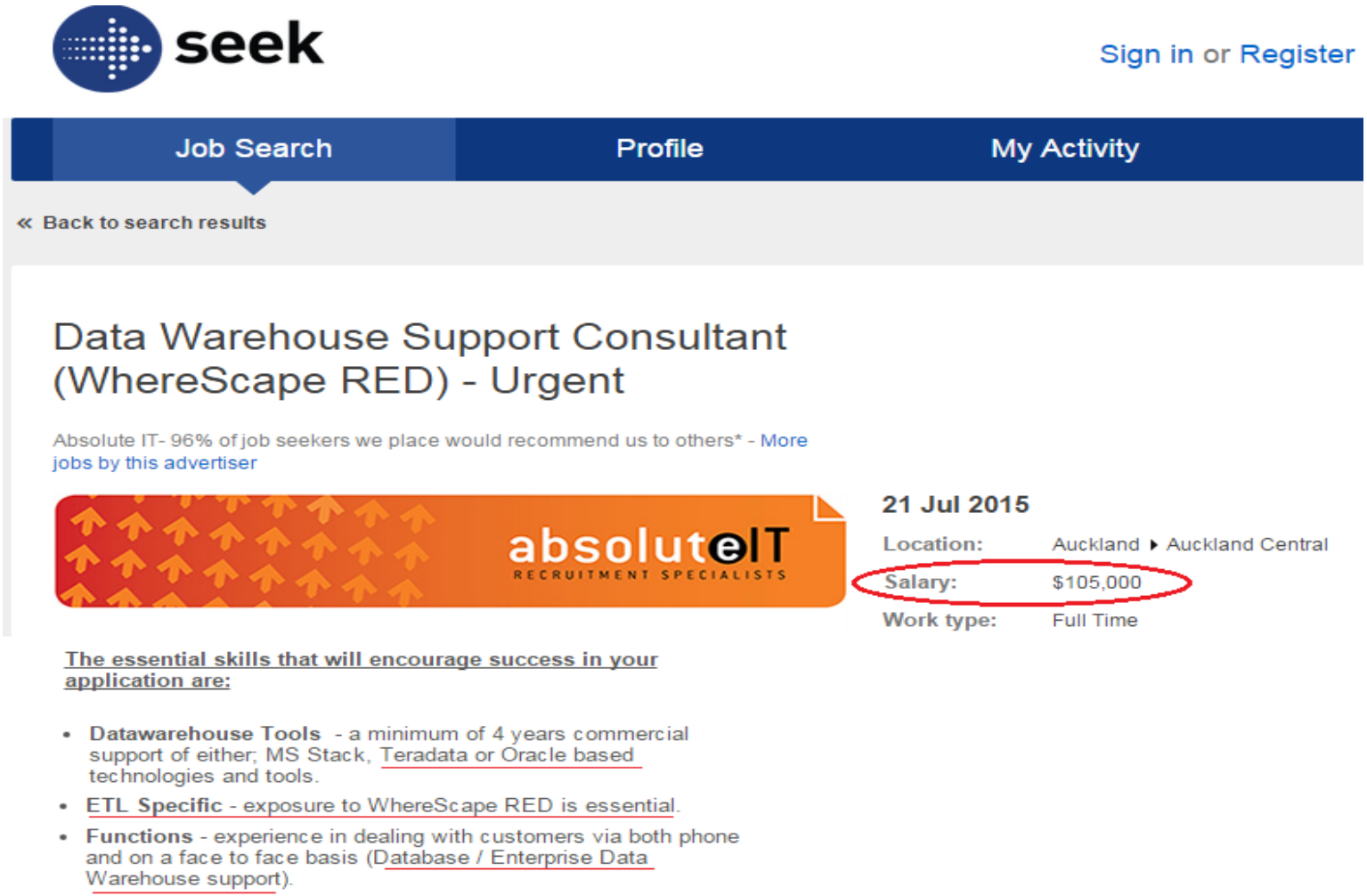
- Data Warehousing & OLAP is important
- It helps to
  - Understand the information **hidden** within the organization's data
    - See data from different angles: product, client, time, geographical area
    - Get adequate statistics to get your point of argumentation across
    - Get a glimpse of the future…



Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Why should you be here?

- And because you **love databases**…



Course Contents and Schedule

WEEK	LECTURE	LAB
1	Introduction to course, Introduction to Data Warehouse	Writing Basic SQL Statements;
2	Lecture on Course Assessments	SQL Operators – Restricting and Sorting Data
3	DW Life Cycle and Basic Architecture	Retrieving Data from Multiple tables
4	DW Architecture (Continued)	SQL functions and Aggregating data using Group Functions
5	Logical Model	Table Creation, Alteration and Applying constraints
6	Physical Model	DML – Insert, Update and Delete Data
Mid Semester Break		
7	Indexes	SQL Practice
8	Optimizations	Creating of DW Schema
9	OLAP Operations and Queries	Working on Project
10	Building the DW	Working on Project
11	Real-Time DW	Working on Project
12	Big Data	No Lab

Assessments

Assessment type	Date
Research Report (20%)	Friday 18th Sep 2015
Project (80%)	Friday 23rd Oct 2015

Important: To pass the paper, student needs to attempt both assessments and obtain a C- grade overall.

Recommended Literature

- Building the Data Warehouse
  - William H. Inmon
  - Wiley, ISBN 978-0-7645-9944-6
- The Data Warehouse Toolkit
  - Ralph Kimball & Margy Ross
  - Wiley, ISBN 978-1-118-53080-1
- Big Data
  - Nathan Marz, James Warren
  - Wiley, ISBN 978-1-617290-34-3

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Lecture 01

Introduction to Data Warehouse

Introduction

I Introduction

1. What is a data warehouse?
2. Applications and users

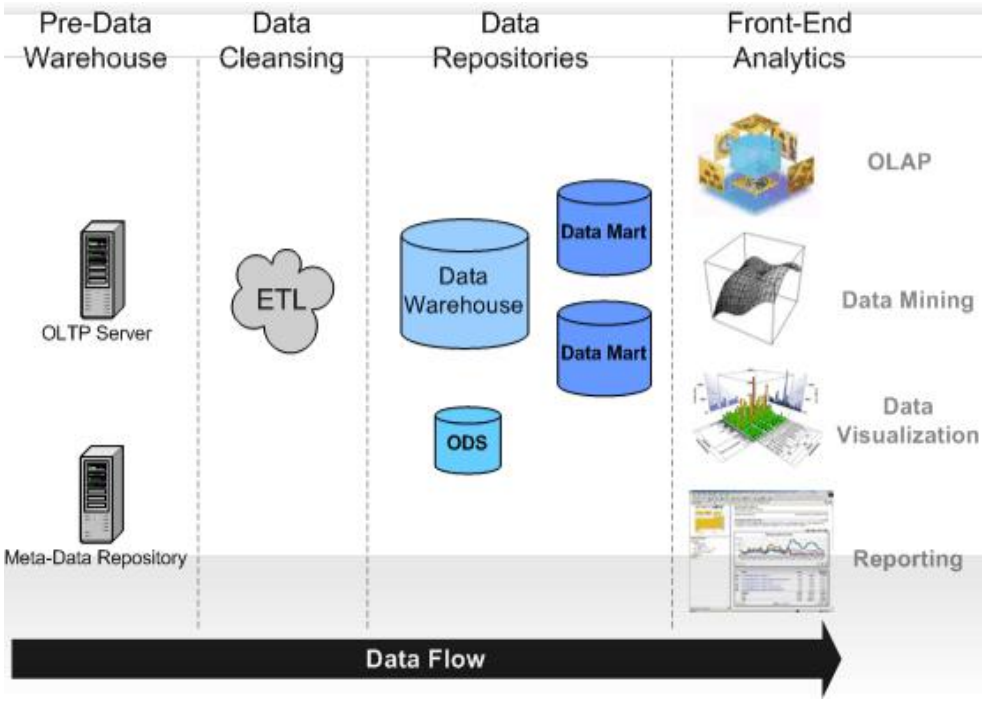
What is a data warehouse?

- Basically a very large **database**…
  - Not all very large databases are data warehouses, but all data warehouses are pretty large databases
  - Nowadays a warehouse is considered to start at around 800 GB and goes up to severalTB
  - It spans over several servers and needs an impressive amount of computing power

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

What is a data warehouse?

- More specific, a **collective data repository**
  - Containing snapshots of the operational data (history)
  - Obtained through data cleansing (Extract-Transform- Load)
  - Useful for analytics



Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

What is a data warehouse?

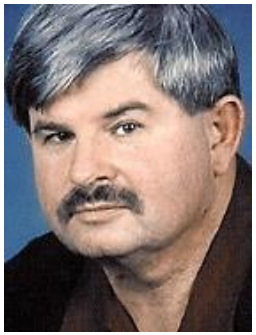
- Compared to other solutions it…
  - Is suitable for **tactical/strategic focus**
  - Implies a **small number of transactions**
  - Implies **large transactions** spanning over a long period of time

	OLTP	ODS	OLAP	DM / DW
Business Focus	Operational	Operational / Tactical	Tactical	Tactical / Strategic
End User Tools	Client/Server or Web	Client/Server or Web	Client/Server	Client/Server or Web
DB Technology	Relational	Relational	Cubic	Relational
Transaction Count	Large	Medium	Small	Small
Transaction Size	Small	Medium	Medium	Large
Transaction Time	Short	Medium	Medium	Long
DB Size in GB	10–400	100–800	100–800	800—80,000
Data Modeling	Traditional ERD	Traditional ERD	N/A	Dimensional
Normalization	3–5 NF[1]	3 NF	N/A	0 NF

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Some Definitions

- Experts say…
  - **Ralph Kimball**:"a copy of transaction data specifically structured for query and analysis"
  - **Bill Inmon**: "A data warehouse is a:
    - Subject oriented
    - Integrated
    - Non-volatile
    - Time variant



collection of data in support of management's decisions."

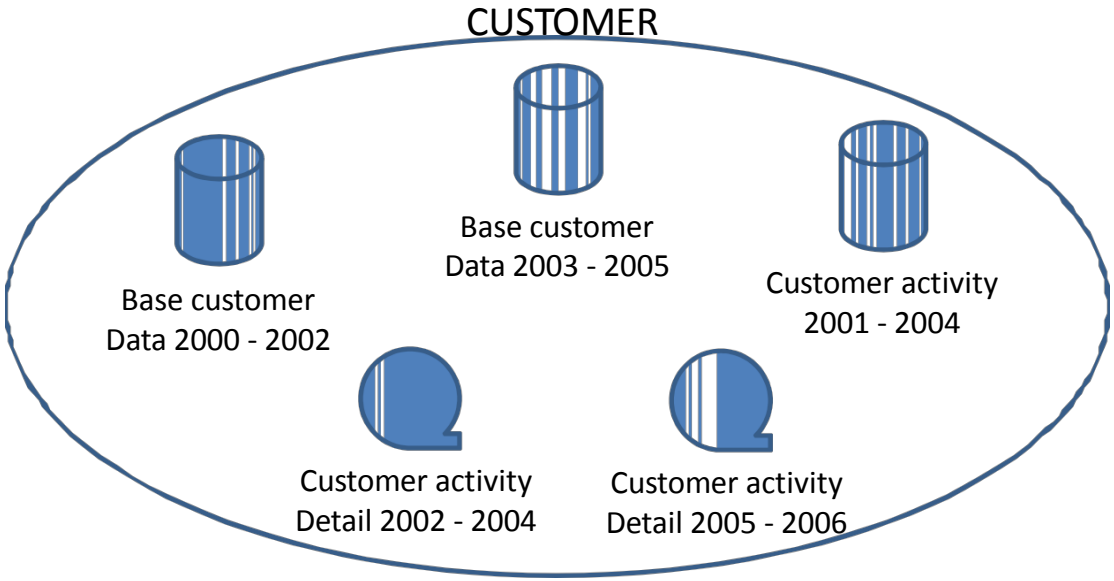
Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Inmon Definition (cont'd.)

- **Subject oriented**
  - The data in the data warehouse is organized so that all the data elements relating to the same real-world event or object are **linked together**
    - Typical subject areas in DWs are Customer, Product, Order, Claim, Account, …

Inmon Definition (cont'd.)

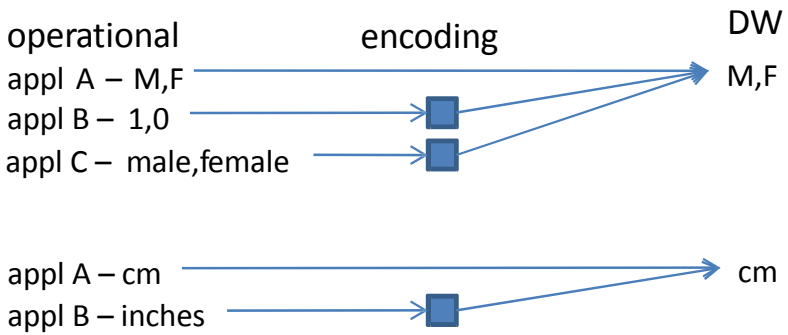
- **Subject oriented**
  - Example: customer as subject in a DW
    - DW is organized in this case by the customer
    - It may consist of 10, 100 or more physical tables, all related



Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

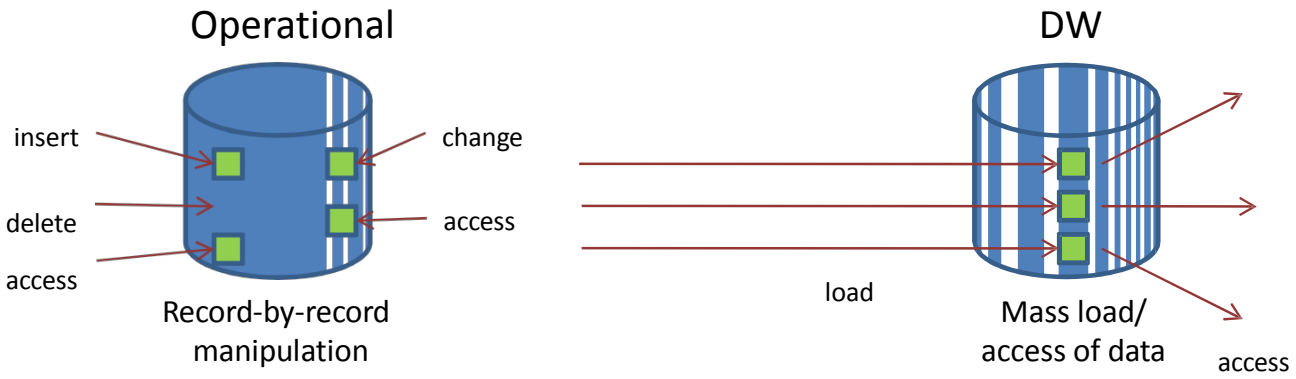
Inmon Definition (cont'd.)

- **Integrated**
  - The data warehouse contains data from **most or all** of an organization's operational systems and this data is made **consistent**
  - E.g. gender, measurement, conflicting keys, consistency, …



Inmon Definition (cont'd.)

- **Non-volatile**
  - Data in the data warehouse is **never over-written** or **deleted** - once committed, the data is static, read-only, and retained for future reporting
  - Data is loaded, but not updated
  - When subsequent changes occur, a new snapshot record is written

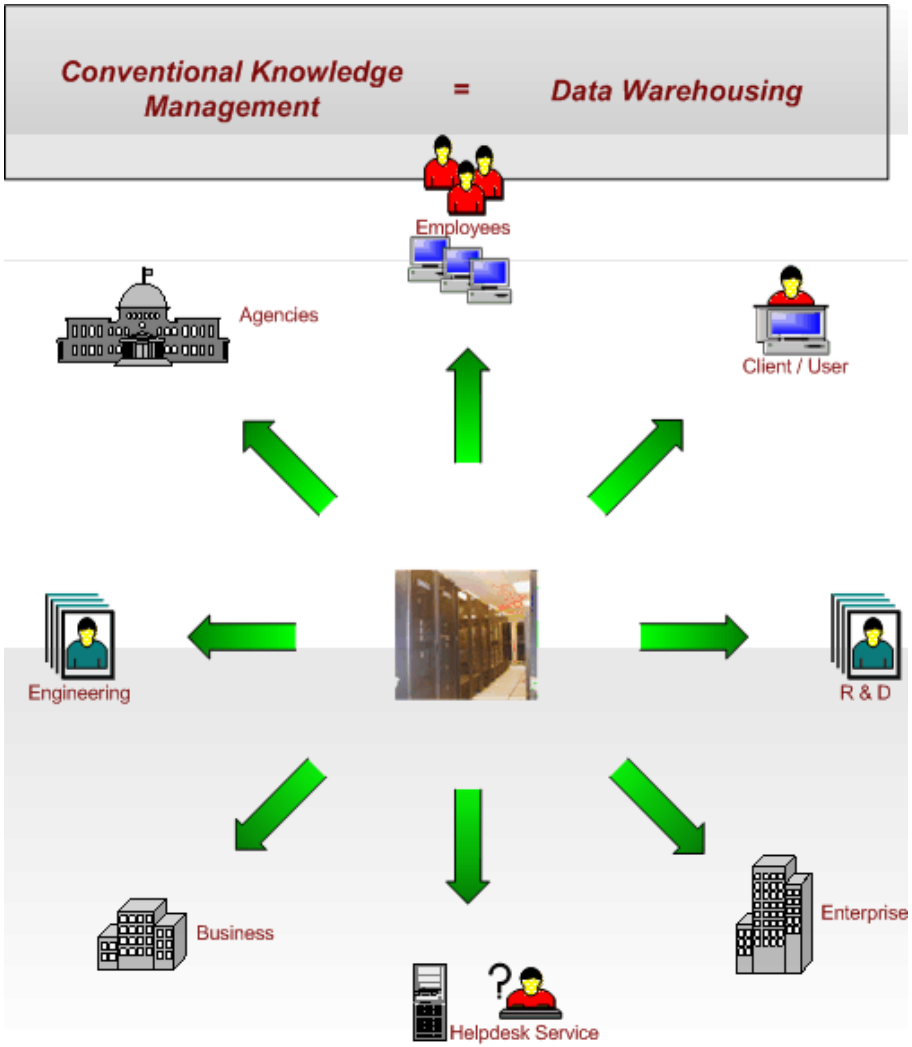


Inmon Definition (cont'd.)

- **Time-varying**
  - The changes to the data in the data warehouse are tracked and recorded so that reports can be produced showing **changes over time**
  - Different environments have different time horizons
  - associated
    - While for operational systems a 60-to-90 day time horizon is normal, data warehouse has a
    - 5-to-10 year horizon

General Definition

- More general,a DW is a
  - Repository of an organization's electronically stored data
  - Designed to facilitate reporting and analysis



Typical Features

- DW typically…
  - Reside on computers **dedicated to this function**
  - **Run on DBMS** such as Oracle, IBM DB2, Teradata or Microsoft SQL Server
  - Retain data for **long periods of time**
  - **Consolidate data** obtained from a variety of sources
  - Are built around their own **carefully designed data model**

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Use case

Detour

- DW stands for big data volume, so lets take an example of **2 big companies**, a retailer, say Walmart and a RDBMS vendor, Sybase:

  - Walmart CEO: *I want to keep track of sales in all my stores simultaneously*
  - Sybase consultant: *You need our wonderful RDBMS software. You can stuff data in as sales are rung up at cash registers and simultaneously query data right in your office*
  - So Walmart buys a $1 milion Sun E10000 multi-CPU server, a $500 000 Sybase license, a book "Database Design for Smarties", and build themselves a normalized SQL data model

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Use case (cont'd.)

Detour

- After a few months of stuffing data into the tables… aWalmart executive asks…
  - *I have noticed that there was a Colgate promotion recently, directed to people who live in small towns. How much toothpaste did we sell in those towns yesterday?*
  - Translation to a query:

```
select sum(sales.quantity_sold) from sales, products, product_categories, manufacturers,
stores, cities where manufacturer_name = 'Colgate'
and product_category_name = 'toothpaste' and cities.population < 40 000
and trunc(sales.date_time_of_sale) = trunc(sysdate-1) and sales.product_id =
products.product_id
and sales.store_id = stores.store_id
and products.product_category_id = product_categories.product_category_id and
products.manufacturer_id = manufacturers.manufacturer_id
and stores.city_id = cities.city_id
```

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Use case (cont'd.)

Detour

- The tables contain large volumes of data and the query implies a **6 way join** so it will take some time to execute
- The tables are at the **same time also updated** by new sales
- Soon after executive start their quest for marketing information store employees notice that there are times during the day when it is impossible to process a sale

→ Any attempt to update the database results in freezing the computer up for 20 minutes

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Use case (cont'd.)

Detour

- In minutes…theWalmart CIO calls Sybase tech support

- Walmart CEO: *WE TYPE IN THE TOOTHPASTE QUERY AND OUR SYSTEM HANGS!!!*
- Sybase support: *Of course it does! You built an **on-line transaction processing (OLTP)** system. You can't feed it a **decision support system (DSS)** query and expect things to work!*

  - Walmart CEO: *!@%$#.I thought this was the whole point of SQL and your RDBMS…to query and insert simultaneously!!*
  - Sybase support: *Uh, not exactly. If you're **reading** from the database, nobody can **write** to the database. If you're **writing** to the database, nobody can **read** from the database. So if you've got a query that takes 20 minutes to run and don't specify **special locking instructions**, nobody can update those tables for 20 minutes.*

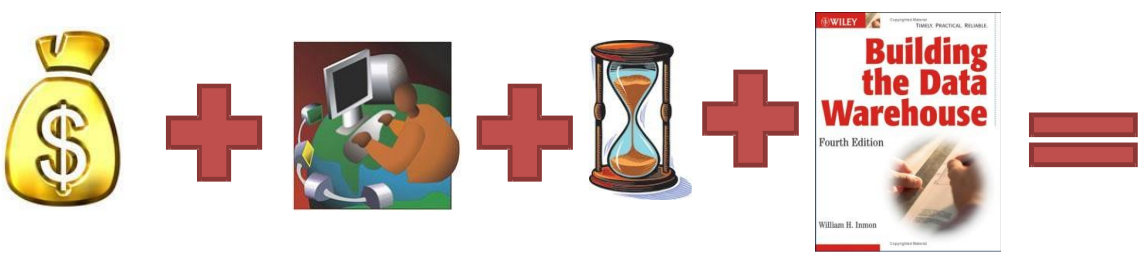
Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

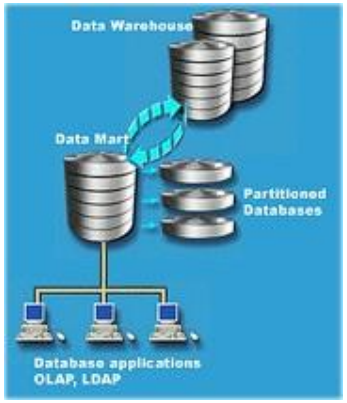
Use case (cont'd.)

Detour

- Walmart CEO: *It sounds like a bug.*
- Sybase support: *Actually it is a feature. We call it **pessimistic locking**.*
- Walmart CEO: *Can you fix your system so that it doesn't lock up???*
- Sybase support: *No. But we made this great loader tool so that you can copy everything from your **OLTP system** into a separate **Data Warehouse system** at 100 GB/hour*

- After a while…





Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

OLTP vs. DW

Detour

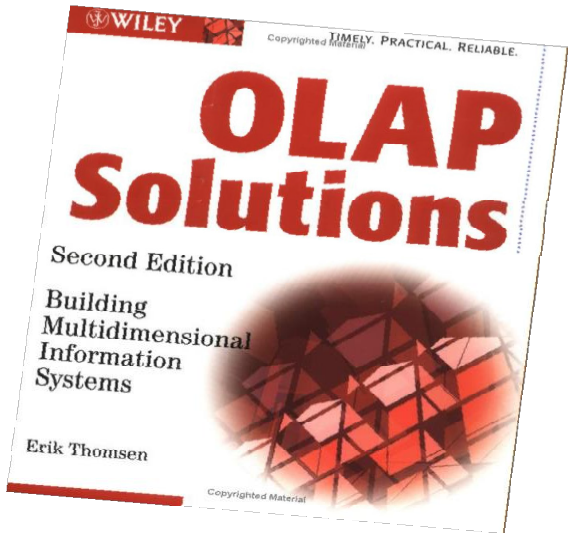
- OLTP (**O**n**L**ine **T**ransaction **P**rocessing):
  - Also known under the name of **operational data**, it represents day-to-day operational business activities:
    - Purchasing, sales, production distribution, …
  - Typically for **data entry** and **retrieval** transaction processing
  - Reflects only the **current state** of the data

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

OLTP vs. DW (cont'd.)

Detour

- OLAP (**O**n**L**ine **A**nalytical **P**rocessing):
  - Represents **front-end analytics** based on a DW repository
  - It provides information for activities like
    - Resource planning, capital budgeting, marketing initiatives, …
  - It is **decision oriented**



OLTP vs. DW (cont'd.)

Detour

- Properties

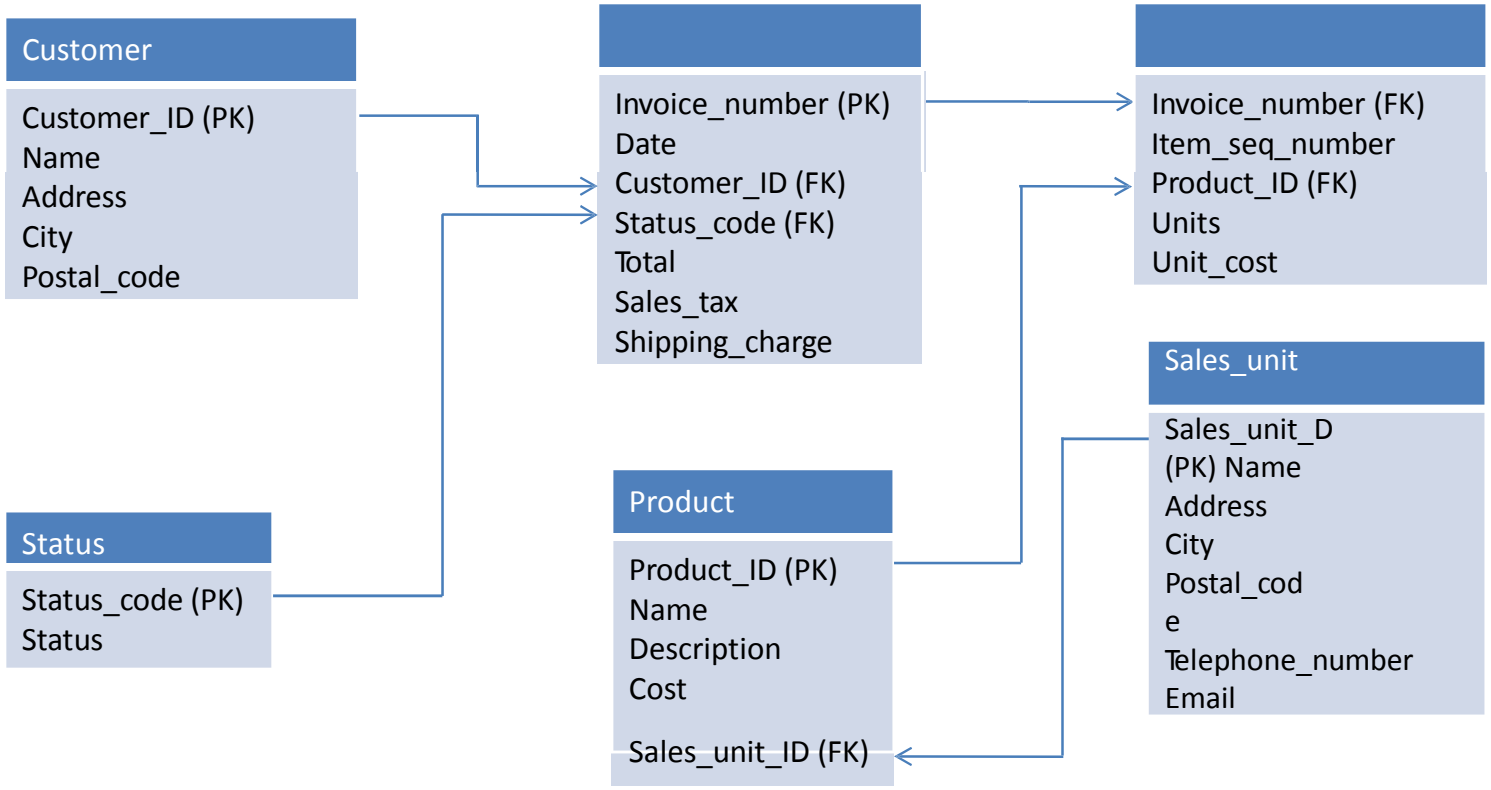
Operational DB	DW
Mostly updates	Mostly reads
Many small transactions	Queries long, complex
MB-TB of data	GB-PB of data
Raw data	Summarized data
Clerical users	Decision makers
Up-to-date data	May be slightly outdated

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

OLTP vs. DW (cont'd.)

Detour

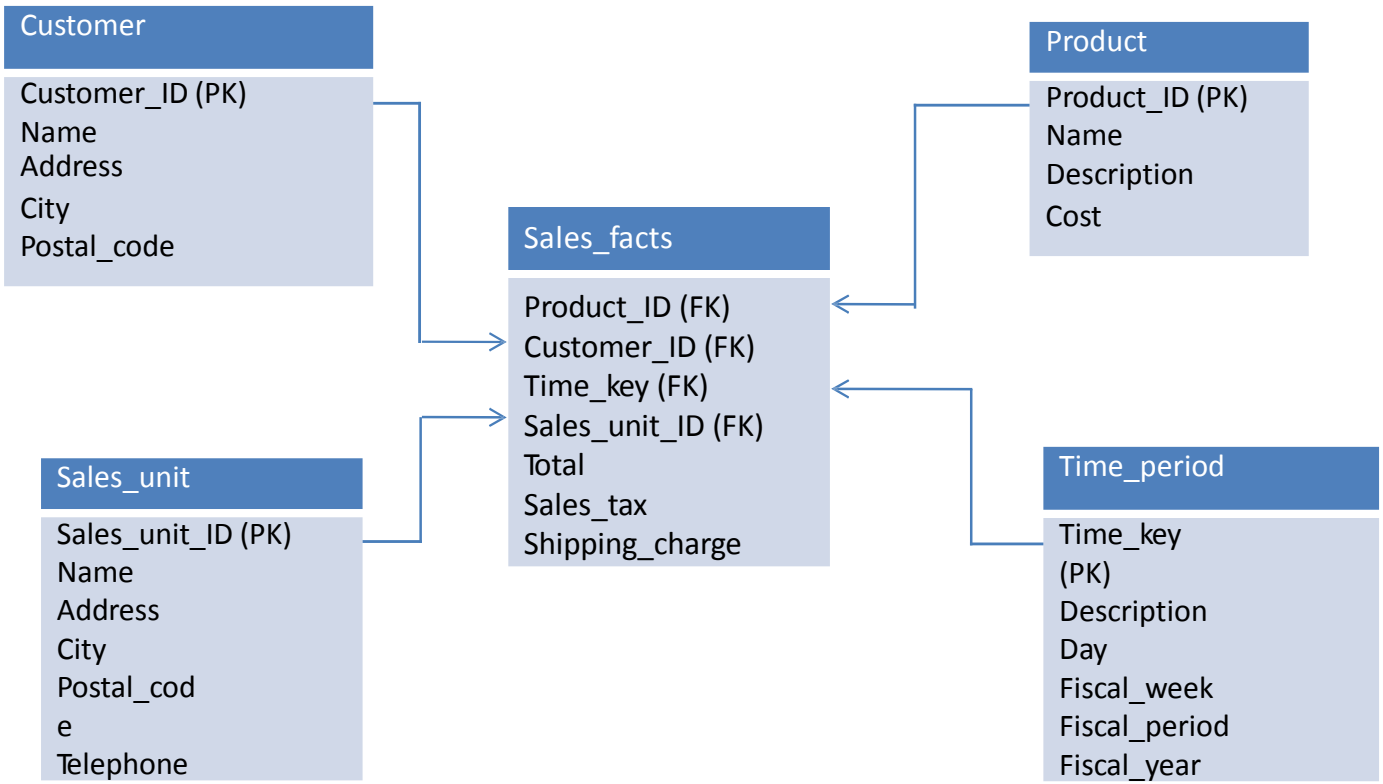
- Consider a **normalized database** for a store
  - The tables would look like this…



OLTP vs. DW (cont'd.)

Detour

- If we were to set up a **DW** for that store, we would start by building the following ***star schema***



Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

OLTP vs. DW (cont'd.)

Detour

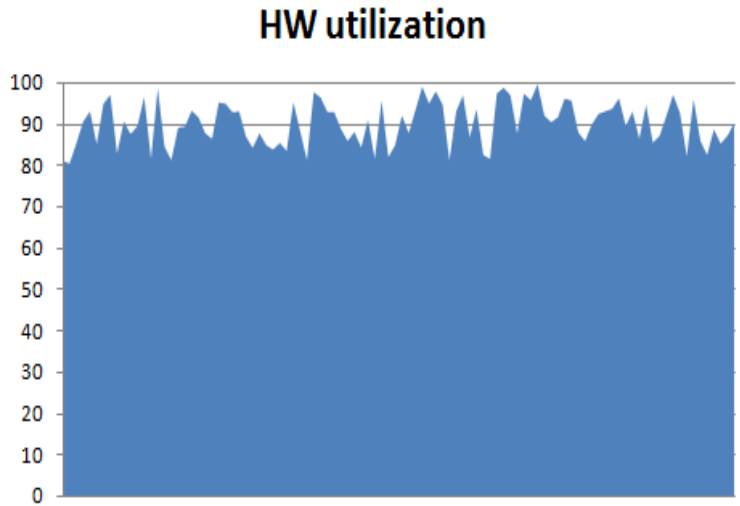
- **Basic insights** from comparing OLTP and DWs
  - A DW is a separate (**RDBMS**) installation that contains copies of data from on-line systems
    - Physically separate hardware may not be absolutely necessary if you have lots of **extra computing power**, but it is recommended
  - With an **optimistic locking** DBMS you might even be able to get away for a while with keeping just one copy of your data

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

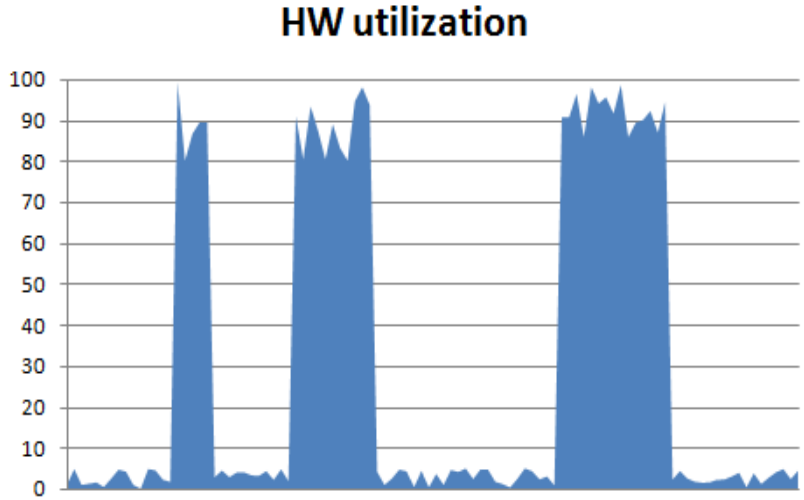
OLTP vs. DW (cont'd.)

Detour

- There is an essentially different pattern of **hardware utilization** between on-line and analytical processing



Operational



Data warehouse

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW

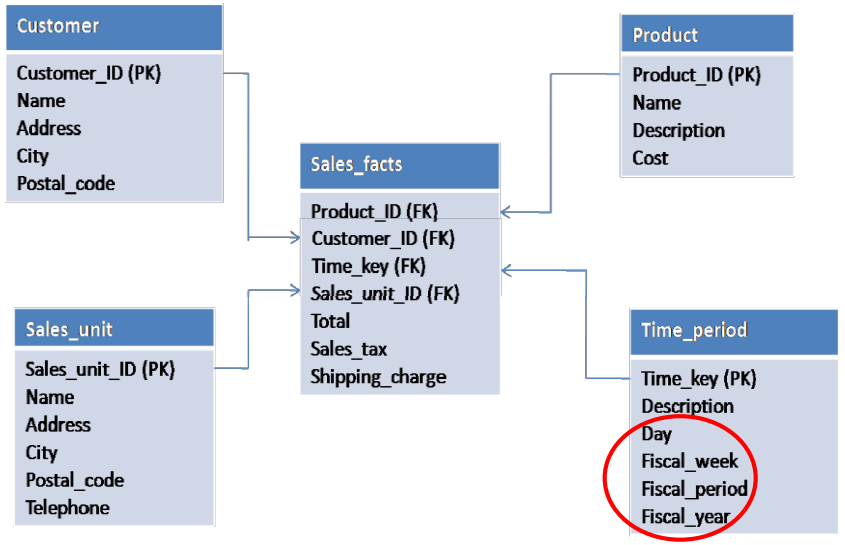
- **Typical questions** which can be answered with DW & OLAP
  - How much did sales unitA earn in January?
  - How much did sales unit B earn in February?

    What was their combined sales amount for the first quarter?
- Answering these questions with **SQL-queries** is difficult
  - Complex query formulation necessary
  - Process is likely to be slow due to complex joins and multiple scans

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW (cont'd.)

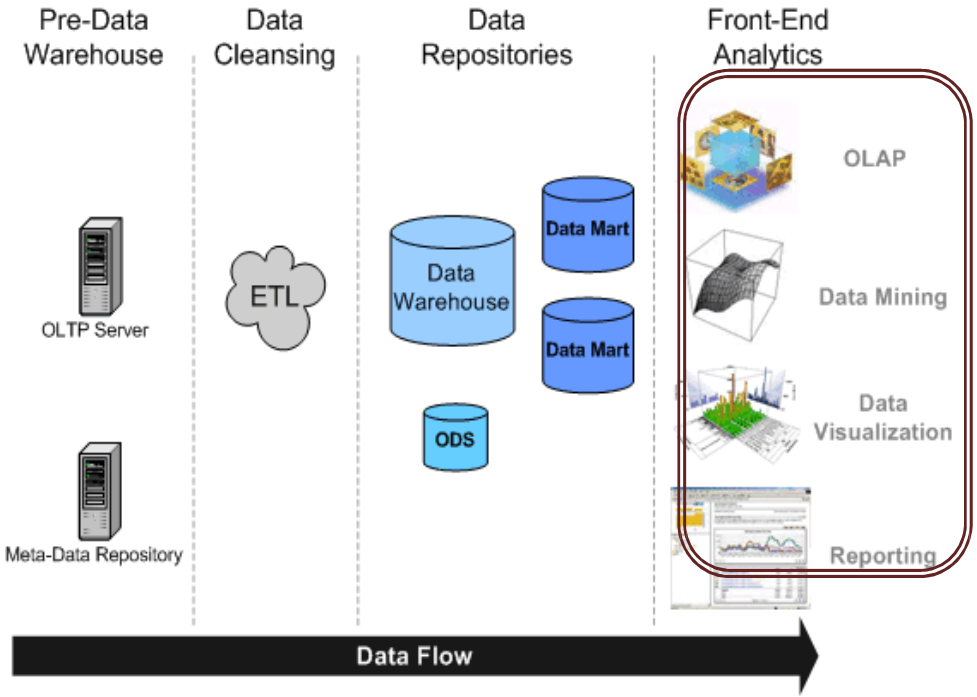
- Why such questions can be answered better with a DW?
  - Because in a DW tables are **rearranged and pre-aggregated** (known as *computing cubes*) e.g. Years, weeks, days etc.
    - The tables arrangement is subject oriented, usually some **star schema**



Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW (cont'd.)

- A DW is the base repository for **front-end analytics**
  - OLAP
  - KDD (**K**nowledge **D**iscovery in **D**atabases) a data mining process
  - Data visualization
  - Reporting



Applications of DW (cont'd.)

- OLAP is a form of information processing and thus needs to provide **timely, accurate** and **understandable** information
  - timely is however a relative term:
    - In OLTP we expect an update to go through in a matter of **seconds**
    - In OLAP the time to answer a query can take **minutes, hours or even longer**

- There are many **flavors** of OLAP
  - ROLAP, DOLAP, MOLAP, WOLAP, HOLAP,…

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW (cont'd.)

- **KDD** (Data Mining)
  - Constructs **models** of the data in question
    - Models can be viewed as high level summaries of the underlying data

ID	Name	ZIP	Sex	Age	Income	Children	Car	Spent
12	Peter	38106	M	35	€ 55,000	2	Mini Van	€ 210.00
15	Gabriel	38100	M	32	€ 56,000	0	SUV	€ 30.00
…	…	…	…	…	…	…	…	…
122	Claire	38106	F	21	€ 42,000	0	Coupe	€ 50.00

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW (cont'd.)

- Based on this example a query returns the **data** that fulfills the constraints
  - SELECT * FROM CUSTOMER_TABLEWHERE TOTAL_SPENT > €100;
- Data mining might return the following **set of rules** for customers spending more than €100:
  - IF AGE > 35 AND CAR = 'MINIVAN' THEN TOTAL SPENT > €100
  - IF SEX = 'M' AND ZIP = 38106 THEN TOTAL SPENT > €100

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Applications of DW (cont'd.)

- It answers **questions** like
  - Which products or customers are more profitable
  - Which outlets have sold the least this year
- In consequence it motivates **decisions** like
  - Which products should have their production increased
  - Which customers should be targeted for special promotions
  - Which outlets should be closed

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Who is the user?

- Users of DW are called **DSS analysts** and usually are business persons
  - Their primary job is to **define** and **discover** information used in corporate **decision-making**
  - The way they think
    - "Give me what I say I want, and then I can tell you what I really want"
    - They work in explorative manner

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Who is the user? (cont'd.)

- Typical **explorative** line of work
  - "Ah! Now that I see what the possibilities are, I can tell what I really want to see. But until I know what the possibilities are, I cannot describe exactly what I want…"
- This usage has fundamental effect on **the way a DW is developed**
  - The classical **system development life cycle** assumes that the requirements are known at the start of design
  - The DSS analyst starts with existing requirements, but **factoring in new requirements** with time

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Summary

- Data Warehouse - Introduction
  - DW Definitions
  - OLTP vs. DW
  - Applications of DW

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides

Next lecture

- Assessments Explanation
  - Assessment 01
  - Assessment 02

Acknowledgment - Thanks to Wolf-Tilo Balke and Silviu Homoceanu - TU Braunschweig for the slides