MSc GFIS

Business Intelligence – Data Warehouse Design

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Objectives

- Creating a Data Warehouse
- Why separate a Data Warehouse?
- Three kinds of DW applications
- The Role of a Business Analyst
- Multidimensional Data Representation and Manipulation
  - Data cube data representation
  - Data cube operators
- Data Warehouse design – star and snowflake schema
- Implementation – things to avoid…
- Important applications and trends in DW technology
  - Understand cloud influence on data warehouse product offerings
- Future

Traditional Applications - examples

Industry	Key Applications
Airline	Yield management, route assessment
Telecommunications	Customer retention, network design
Insurance	Risk assessment, product design, fraud detection
Retail	Target marketing, supply-chain management

Creating a Data Warehouse

What do you want to know?

Data Warehouse vs Operational Database

- Operational database – e.g. transaction processing system. Also known as Online Transaction Processing System OLTP
  - Major task of traditional relational DBMS – Day-to-day operations: purchasing, inventory, banking, manufacturing, payroll, registration, accounting, etc.

- Data Warehouse – is to provide analysis. Online Analytical Processing (OLAP)
  - OLAP connects to a data warehouse system –
    - Data analysis and decision making
    - Can organize and present data in various forms and combinations

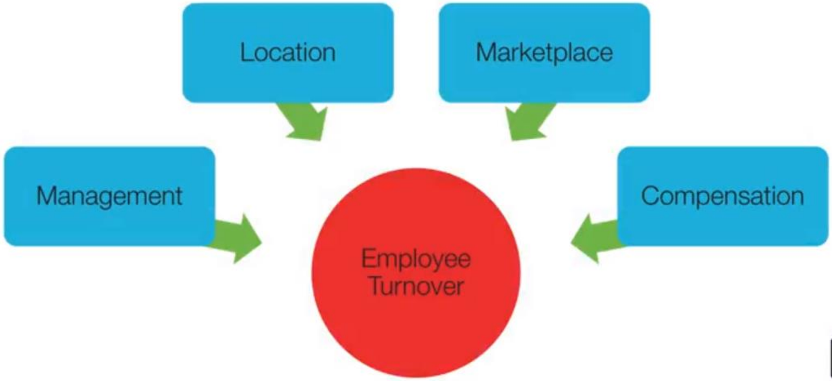
Why separate a Data Warehouse?

- High performance for both systems
  - DBMS— tuned for OLTP: access methods, indexing, concurrency control, recovery
  - Warehouse—tuned for OLAP: complex OLAP queries, multidimensional view, consolidation.
- Different functions and different data:
  - Missing data: Decision support requires historical data which operational DBs do not typically maintain
  - Data consolidation: DS requires consolidation (aggregation, summarization) of data from heterogeneous sources
  - Data quality: different sources typically use inconsistent data representations, codes and formats which have to be reconciled

Three kinds of DW applications:

- Information processing –
  - supports querying, basic statistical analysis, and reporting using crosstabs, tables, charts and graphs
- Analytical processing –
  - multidimensional analysis of data warehouse
  - supports basic OLAP operations, slice-dice, drilling, pivoting
- Data mining –
  - knowledge discovery from hidden patterns
  - supports associations, constructing analytical models, performing classification and prediction, and presenting the mining results using visualization tools.

The Role of a Business Analyst

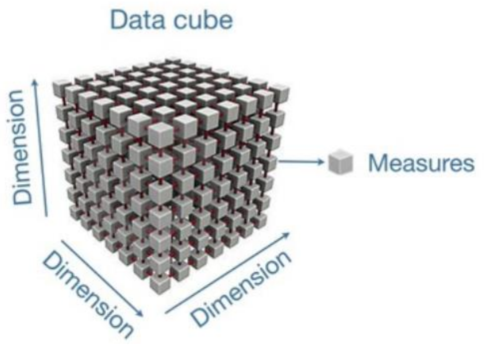


- People who work with accessing data in a data warehouse are known as Business analysts.
- Business analysts typically think about problems from a perspective of factors – such as location, impacting an outcome variable, such as an employee turnover
- Early developers of DW software developed a data model, known as, “data cube”, to support this type of reasoning.

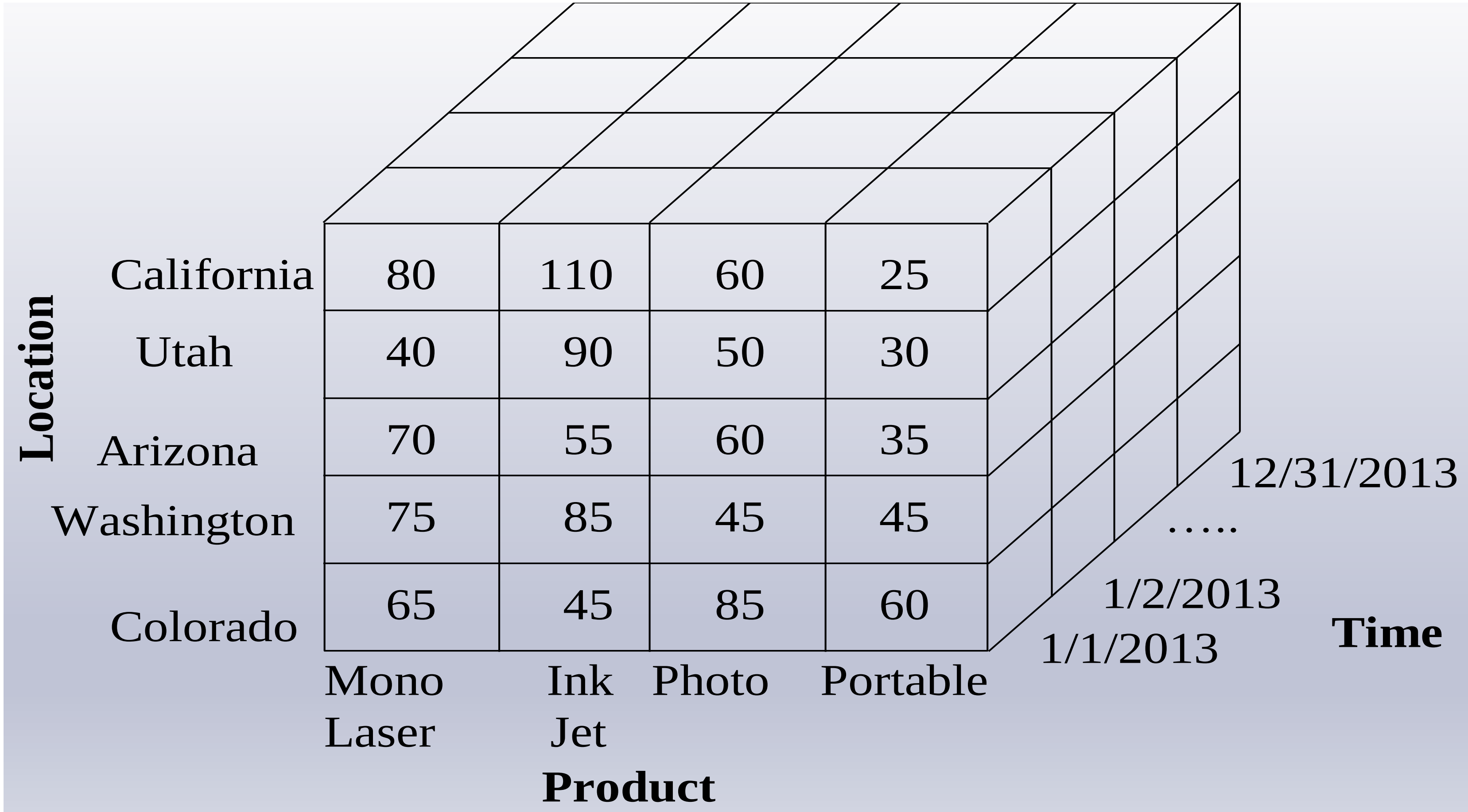
Data Cube Basics

- Business analyst
  - Starts with factors or influencing variables of interest
  - Quantitative variables – e.g. unit
  - Multidimensional arrangement
- Steps involved are:
  - Source – create data view – create cube
- Terminology
  - Dimension: subject label for a row or column
    - Dimensions are organized into hierarchies
    - Dimensions have attributes
  - Measure: quantitative variables stored in cells

Multi-dimensional data model



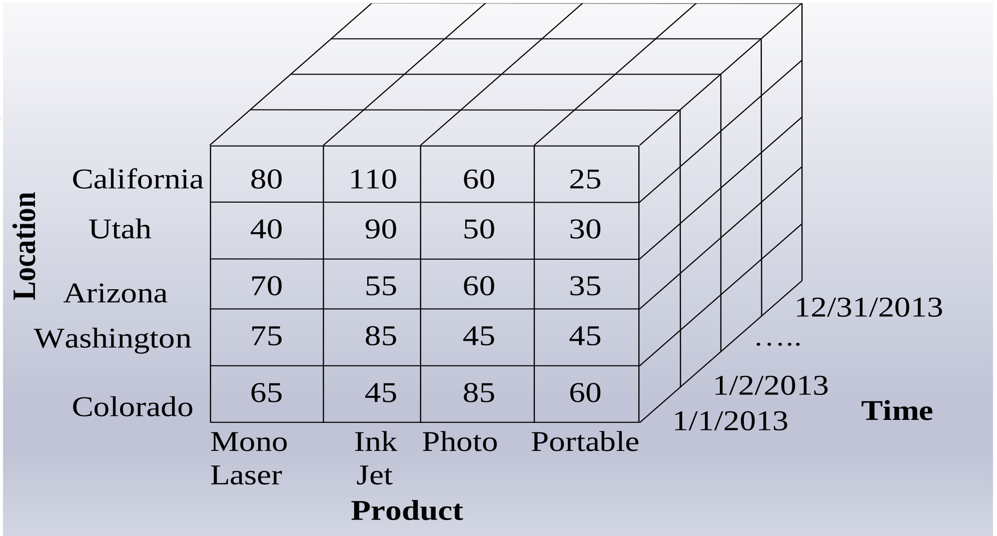
Sales Data Cube Example



	Mono Laser	Ink Jet	Photo	Portable
California	80	110	60	25
Utah	40	90	50	30
Arizona	70	55	60	35
Washington	75	85	45	45
Colorado	65	45	85	60

Slice Operator

- Subset of dimensions
- Set dimension to specific value



Location	Mono Laser	Ink Jet	Photo	Portable
California	80	110	60	25
Utah	40	90	50	30
Arizona	70	55	60	35
Washington	75	85	45	45
Colorado	65	45	85	60

(Location × Product Slice for Time = 1/1/2013)

Location	**Product**			
	Mono Laser	*Ink Jet*	*Photo*	*Portable*
California	80	110	60	25
Utah	40	90	50	30
Arizona	70	55	60	35
Washington	75	85	45	45
Colorado	65	45	85	60

Dice Operator

- Replace a dimension with a subset of values
- Dice operation often follows a slice operation

Location	Product			
	Mono Laser	*Ink Jet*	*Photo*	*Portable*
California	80	110	60	25
Utah	40	90	50	30
Arizona	70	55	60	35
Washington	75	85	45	45
Colorado	65	45	85	60

(Utah, Colorado, Arizona Dice)

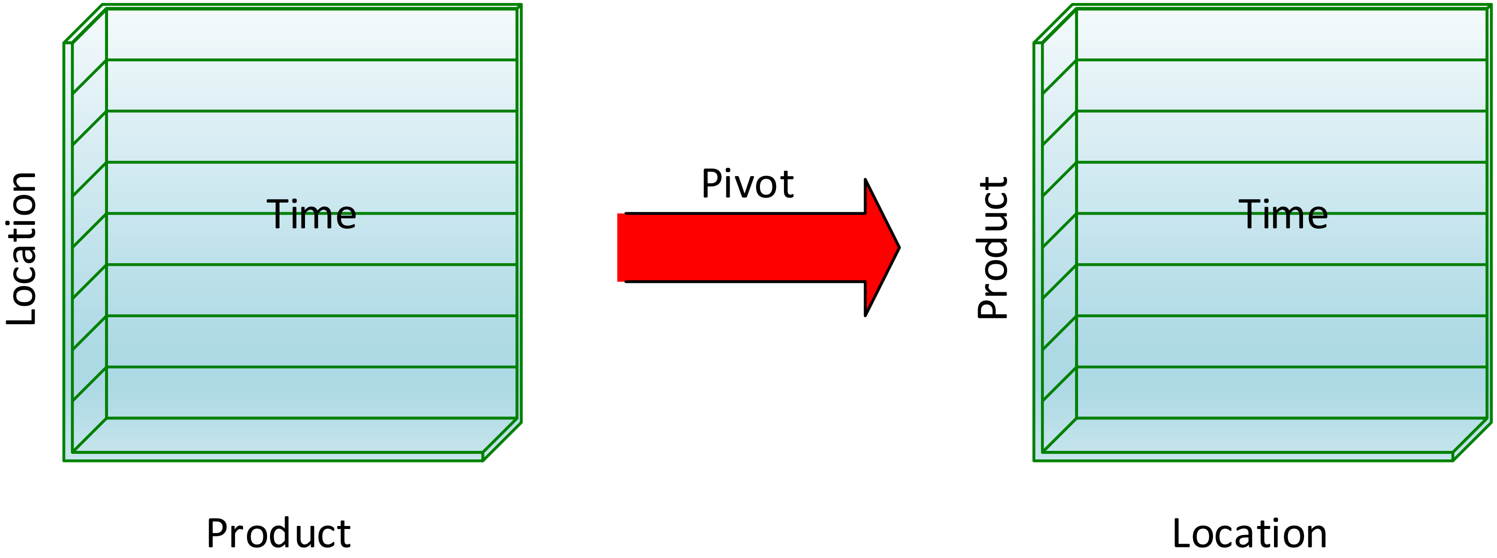
Location	Product			
	Mono Laser	*Ink Jet*	*Photo*	*Portable*
Utah	40	90	50	30
Arizona	70	55	60	35
Colorado	65	45	85	60

Drill-down Example

Location	Product			
	Mono Laser	Ink Jet	Photo	Portable
California	80	110	60	25
- Utah				
Salt Lake	20	20	10	15
Park City	5	30	10	5
Ogden	15	40	30	10
Arizona	70	55	60	35
Washington	75	85	45	45
Colorado	65	45	85	60

Pivot Operator

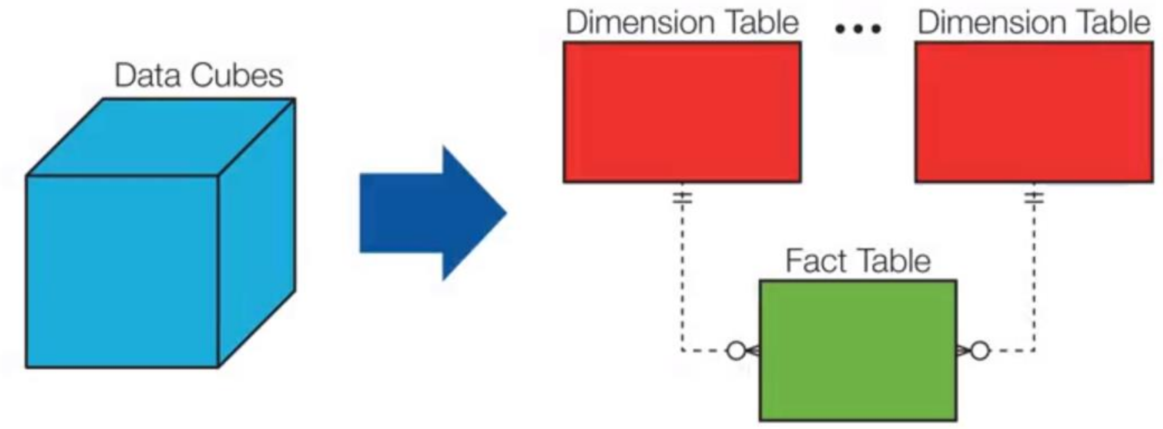
- Rotate or rearrange dimensions



Operator Summary

Operator	Purpose	Description
Slice	Focus attention on a subset of dimensions	Replace a dimension with a single member value or with a summary of its measure values
Dice	Focus attention on a subset of member values	Replace a dimension with a subset of members
Drill-down	Obtain more detail about a dimension	Navigate from a more general level to a more specific level
Roll-up	Summarize details about a dimension	Navigate from a more specific level to a more general level
Pivot	Present data in a different order	Rearrange the dimensions in a data cube

Schema design



- The term "**schema**" refers to the organization of data
- A database uses relational model, while a data warehouse uses Star and/or Snowflake

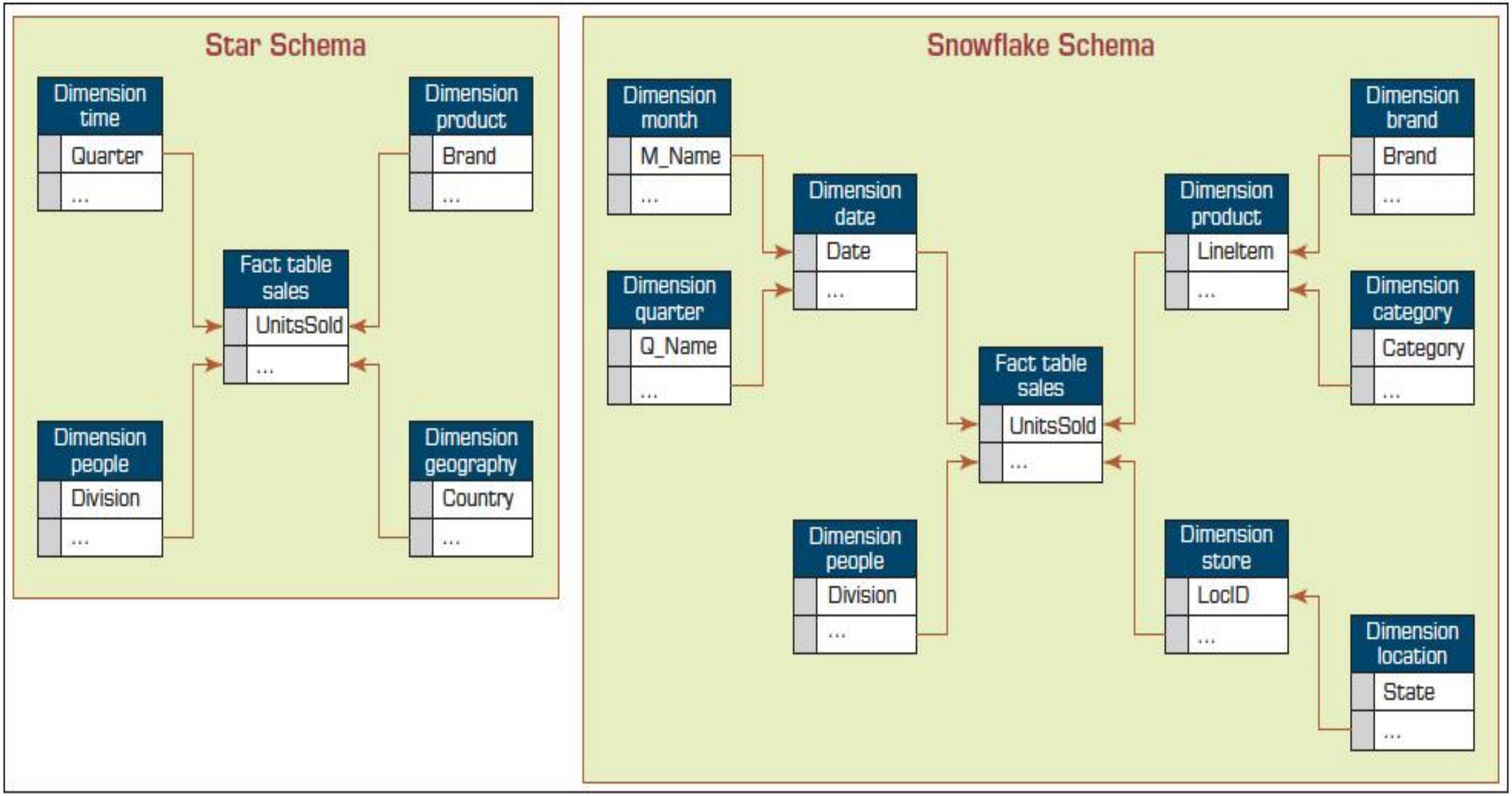
The “Classic” Star Schema

- A relational model with a one-to-many relationship between dimension table and fact table.
- A single fact table, with detail and summary data
- Fact table primary key has only one key column per dimension
- Each dimension is a single table, highly denormalized
- **Benefits**: Easy to understand, intuitive mapping between the business entities, easy to define hierarchies, reduces # of physical joins, low maintenance, very simple metadata
- **Drawbacks**: Summary data in the fact table yields poorer performance for summary levels, huge dimension tables a problem

Snowflake Schema

- Snowflake schema is a type of star schema but a more complex model.
- “Snowflaking” is a method of normalizing the dimension tables in a star schema.
- The normalization eliminates redundancy.
- The result is more complex queries and reduced query performance.

Star Schema versus Snowflake Schema



DW Implementation: Things to Avoid

- Starting with the wrong sponsorship chain
- Setting expectations that you cannot meet
- Engaging in politically naive behavior
- Loading the data warehouse with information just because it is available
- Believing that data warehousing database design is the same as transactional database design
- Choosing a data warehouse manager who is technology oriented rather than user oriented

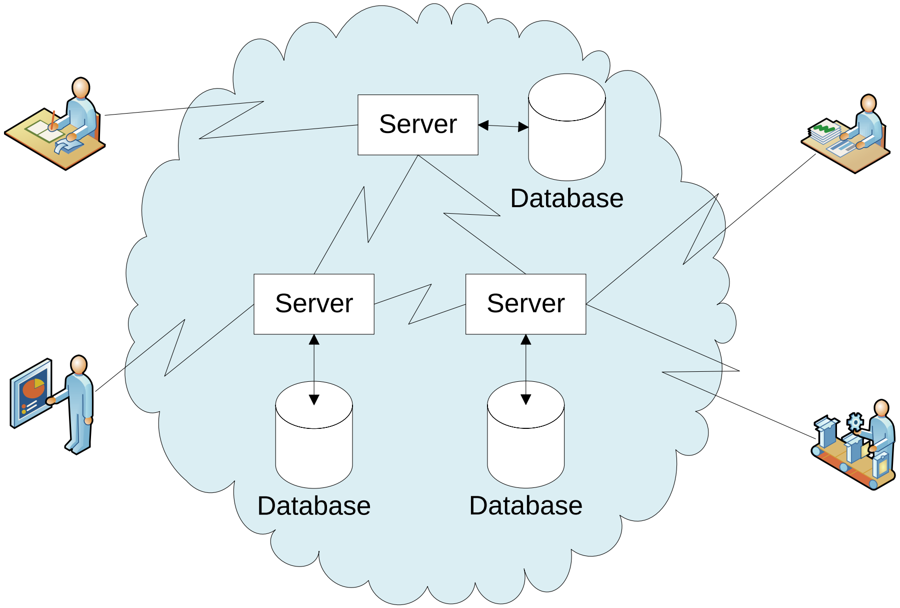
DW Implementation: Things to Avoid

- Focusing on traditional internal record-oriented data and ignoring the value of external data and of text, images, etc.
- Delivering data with confusing definitions
- Believing promises of performance, capacity, and scalability
- Believing that your problems are over when the data warehouse is up and running
- Focusing on ad hoc and periodic reporting instead of alerts

Market Shares and Trends

- Major vendors: Teradata, Oracle, IBM, Microsoft, SAP
- Large projected market growth
- Trends
  - Real time load and analysis
  - Increased storage and analysis of social interactions
  - Increased usage of cloud services and appliances

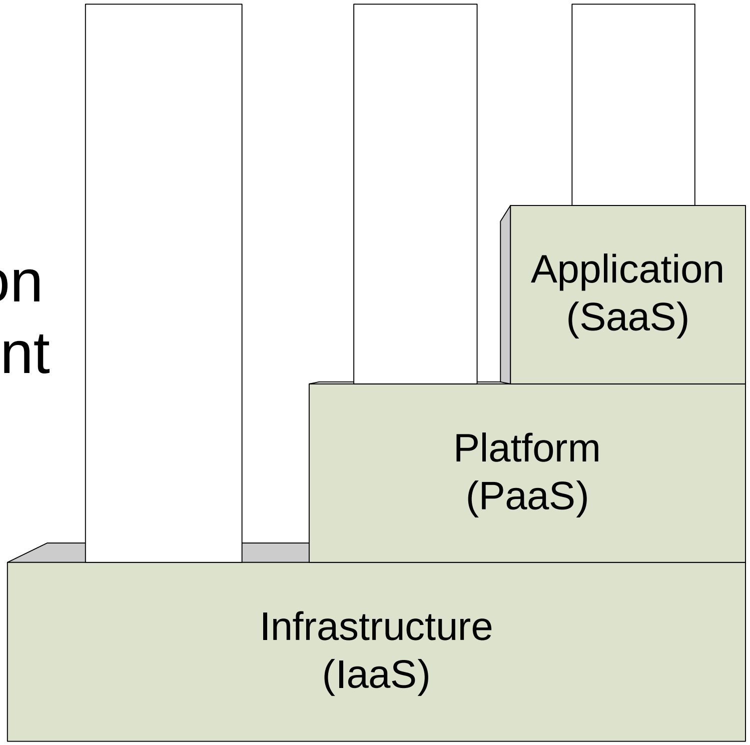
Cloud Influence



- Reduces local expertise to procure technology and manage a data warehouse
- Economies of scale
- Improved scalability
- Higher variable costs but lower fixed costs

Cloud Service Models

User
Organization
Development



Application
(SaaS)

Platform
(PaaS)

Infrastructure
(IaaS)

Cloud Vendor
Infrastructure

AMAZON REDSHIFT

TERADATA
Raising Intelligence

dashDB

snowflake

Massive DW and Scalability

- Scalability
  - The main issues pertaining to scalability:
    - The amount of data in the warehouse
    - How quickly the warehouse is expected to grow
    - The number of concurrent users
    - The complexity of user queries
  - Good scalability means that queries and other data-access functions will grow linearly with the size of the warehouse

The Future of DW

- Sourcing…
  - *Web, social media, and Big Data*
  - Open source software
  - SaaS (software as a service)
  - Cloud computing
  - Data lakes
- Infrastructure…
  - Columnar
  - Real-time DW
  - Data warehouse appliances
  - Data management practices/technologies
  - In-database & In-memory processing New DBMS
  - New DBMS, Advanced analytics, …

Resources:

- Data Warehousing Concepts: a brief overview of several concepts in data warehousing. It describes dimensional modeling and some of its features and different types of OLAP technology.

- Inmon vs Kimball – which approach?

- Star vs snowflake – which is better?

- Sandboxes – e-bay's example - user controlled spaces for data analysis