DATA WAREHOUSING & DATA MINING

by:

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UNIT-I

Overview and Concepts

Contents of Unit-I

- Need for data warehousing, Basic elements of data warehousing, Trends in data warehousing. Planning
- And Requirements: Project planning and management, Collecting the requirements. Architecture And
- Infrastructure: Architectural components, Infrastructure and metadata

Text Books:

- Prabhu,Data ware housing- concepts, Techniques, Products and Applications, Prentice hall of India
- Soman K P, “Insight into Data Mining: Theory & Pratice” , Prentice hall of India
- M.H. Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education.

Reference Books:

- **Paulraj Ponniah, “Data Warehousing Fundamentals”, John Wiley.**
- **Arun K. Pujari, “Data mining Techniques”, Universities Press.**
- Ralph Kimball, “The Data Warehouse Lifecycle toolkit”, John Wiley.
- IBM, “Introduction to Building The Data warehouse” PHI

What is Data Warehousing?

A process of transforming **data** into **information** and making it available to users in a timely enough manner to make a difference

Data Warehousing -- It is a process

- Technique for **assembling** and **managing data** from **various sources** for the purpose of **answering business questions**. Thus making decisions that were not previous possible

A decision support database maintained separately from the organization's operational database

What is Data Warehouse?

- "A data warehouse is a **subject-oriented**, **integrated**, **time-variant**, and **nonvolatile** collection of data in support of management's **decision-making** process."—W. H. Inmon
- Data warehousing:
  - The process of constructing and using data warehouses

Data Warehouse—Subject-Oriented

- **Organized around major subjects**, such as customer, product, sales.
- Focusing on the modeling and analysis of data for decision makers, not on daily operations or transaction processing.
- Provide a simple and concise view around particular subject issues by excluding data that are not useful in the decision support process.

Data Warehouse—Integrated

- Constructed by **integrating multiple, heterogeneous data sources**
  - relational databases, flat files, on-line transaction records
- **Data cleaning and data integration techniques** are applied.
  - Ensure consistency in naming conventions, encoding structures, attribute measures, etc. among different data sources
    - E.g., Hotel price: currency, tax, breakfast covered, etc.
  - **When data is moved to the warehouse, it is converted.**

Data Warehouse—Time Variant

- The time horizon for the data warehouse is significantly longer than that of operational systems.
  - Operational database: **current value data.**
  - Data warehouse data: provide information from a **historical** perspective (e.g., **past 5-10 years**)
- Every key structure in the data warehouse
  - Contains an element of time, explicitly or implicitly
  - But the key of operational data may or may not contain “time element”.

Data Warehouse—Non-Volatile

- A **physically separate store** of data transformed from the operational environment.
- Operational **update of data does not occur** in the data warehouse environment.
  - Does not require transaction processing, recovery, and concurrency control mechanisms
  - Requires only two operations in data accessing:
    - ***initial loading of data*** and ***access of data***.

Very Large Data Bases

- **Terabytes -- 10^12 bytes:** Walmart-- 24 Terabytes
- **Petabytes -- 10^15 bytes:** Geographic Information Systems
- **Exabytes -- 10^18 bytes:** National Medical Records
- **Zettabytes -- 10^21 bytes:** Weather images
- **Zottabytes -- 10^24 bytes:** Intelligence Agency Videos

Data Warehousing

- **Physical separation of operational and decision support environments**
- **Purpose: to establish a *data repository* making operational data accessible**
- **Transforms operational data to relational form**
- **Only data needed for decision support come from the TPS**
- **Data are transformed and integrated into a consistent structure**
- **Data warehousing (information warehousing): solves the data access problem**
- **End users perform ad hoc query, reporting analysis and visualization**

Evolution of Data Warehouse

Data Warehouse vs. Heterogeneous DBMS

- **Traditional heterogeneous DB integration**:
  - Build on top of heterogeneous databases
  - **Query driven** approach
    - When a query is posed to a client site, a meta-dictionary is used to translate the query into queries appropriate for individual heterogeneous sites involved, and the results are integrated into a global answer set
    - Complex information filtering, compete for resources
- **Data warehouse**: **update-driven**, **high performance**
  - Information from **heterogeneous sources** is **integrated in advance and stored in warehouses for direct query and analysis**

Benefits of Data warehouse

- Better Information
- Better Strategies and plans
- Better tactics and decisions
- More efficient processed
- Time saving
- Reduction in paper reporting

Data Warehousing Benefits

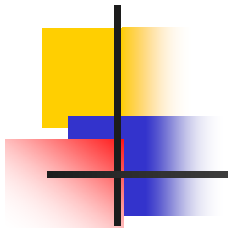
- Increase in knowledge worker productivity
- Supports all decision makers' data requirements
- Provide ready access to critical data
- Insulates operation databases from ad hoc processing
- Provides high-level summary information
- Provides drill down capabilities
  Yields
  - Improved business knowledge
  - Competitive advantage
  - Enhances customer service and satisfaction
  - Facilitates decision making
  - Help streamline business processes

Benefits of DW

- Executives, managers and staff are provided with improved access to data from many databases with in the organization.
- Manager manage with the data they want rather than the data they get.
- Less time spent gathering data from various systems and more time available to analyze and act.
- Ability to quickly answer a series of questions, each of which depends upon the answer to the previous question. (in a sec or min)

Data Warehouse vs. Operational DBMS

- **OLTP (on-line transaction processing)**
  - Major task of traditional relational DBMS
  - Day-to-day operations: purchasing, inventory, banking, manufacturing, payroll, registration, accounting, etc.
- **OLAP (on-line analytical processing)**
  - Major task of data warehouse system
  - Data analysis and decision making
- **Distinct features (OLTP vs. OLAP):**
  - User and system orientation: customer vs. market
  - Data contents: current, detailed vs. historical, consolidated
  - Database design: ER + application vs. star + subject
  - View: current, local vs. evolutionary, integrated
  - Access patterns: update vs. read-only but complex queries



OLTP vs. Data Warehouse

- OLTP systems are tuned for known transactions and workloads while workload is not known a priori in a data warehouse
- Special data organization, access methods and implementation methods are needed to support data warehouse queries (typically multidimensional queries)

OLTP vs Data Warehouse

- **OLTP**
  - Application Oriented
  - Used to run business
  - Detailed data
  - Current up to date
  - Isolated Data
  - Repetitive access
  - Clerical User
- **Warehouse (DSS)**
  - Subject Oriented
  - Used to analyze business
  - Summarized and refined
  - Snapshot data
  - Integrated Data
  - Ad-hoc access
  - Knowledge User (Manager)

OLTP vs Data Warehouse

- **OLTP**
  - Performance Sensitive
  - Few Records accessed at a time (tens)
  - Read/Update Access
  - No data redundancy
  - Database Size 100MB - 100 GB
- **Data Warehouse**
  - Performance relaxed
  - Large volumes accessed at a time(millions)
  - Mostly Read (Batch Update)
  - Redundancy present
  - Database Size 100 GB - few terabytes

OLTP vs Data Warehouse

- **OLTP**
  - Transaction throughput is the performance metric
  - Thousands of users
  - Managed in entirety(whole)
- **Data Warehouse**
  - Query throughput is the performance metric
  - Hundreds of users
  - Managed by subsets

To summarize …

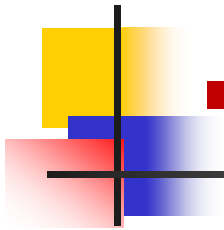
- **OLTP Systems are used to *"run"* a business**

- **The Data Warehouse helps to *"optimize"* the business**

OLTP vs. OLAP

	OLTP	OLAP
users	clerk, IT professional	knowledge worker
function	day to day operations	decision support
DB design	application-oriented	subject-oriented
data	current, up-to-date detailed, flat relational isolated	historical, summarized, multidimensional integrated, consolidated
usage	repetitive	ad-hoc
access	read/write index/hash on prim. key	lots of scans
unit of work	short, simple transaction	complex query
# records accessed	tens	millions
#users	thousands	hundreds
DB size	100MB-GB	100GB-TB
metric	transaction throughput	query throughput, response

The Goals of a Data Warehouse



Goals of Data Warehouse

Makes an organization's information accessible.

Makes the organization's information consistent.

Is an adaptive and durable source of information

Is a secure support that protects the organization's information asset.

Is the foundation for decision making

Needs for Data Warehousing

Why We need Separate Data Warehouse?

- **missing data: Decision support requires historical data which operational DBs do not typically maintain**
- **data consolidation: Decision Support 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**

Trends in Data Warehouse

Three Complementary Trends

- **Data Warehousing**

_ Consolidate data from many sources in one large repository.

– Loading, periodic synchronization of replicas.

– Semantic integration.

- **OLAP:**

– Complex SQL queries and views.

– Queries based on spreadsheet-style operations and multidimensional" view of data.

- – Interactive and "online" queries.
- **Data Mining**

_ Exploratory search for interesting trends and anomalies.

Architecture and Infrastructure

Design of a Data Warehouse: A Business Analysis Framework

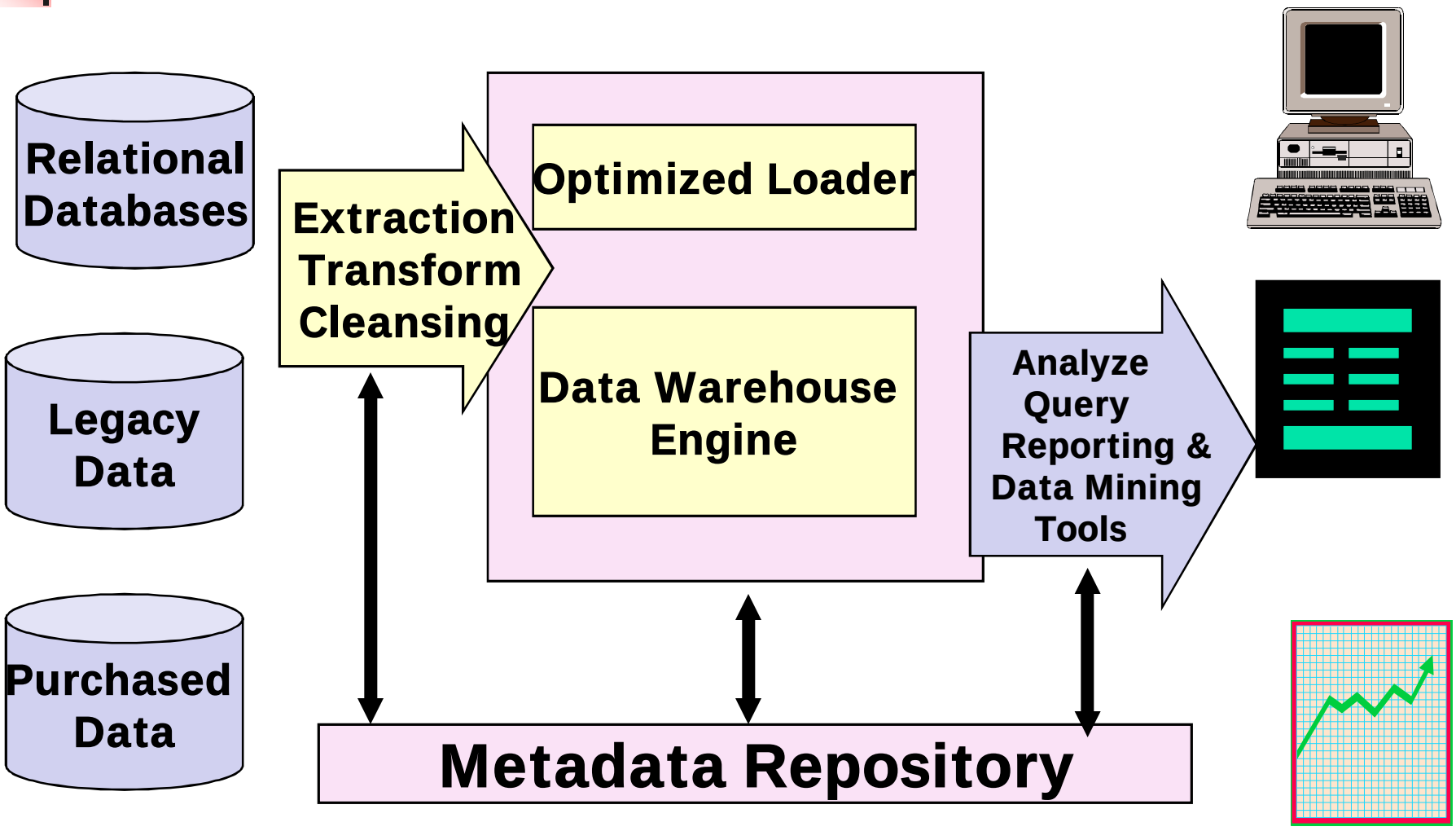
- Four views regarding the design of a data warehouse
  - **Top-down view**
    - allows selection of the relevant information necessary for the data warehouse
  - **Data source view**
    - exposes the information being captured, stored, and managed by operational systems
  - **Data warehouse view**
    - consists of fact tables and dimension tables
  - **Business query view**
    - sees the perspectives of data in the warehouse from the view of end-user

- **Basic Elements of Data Warehouse**

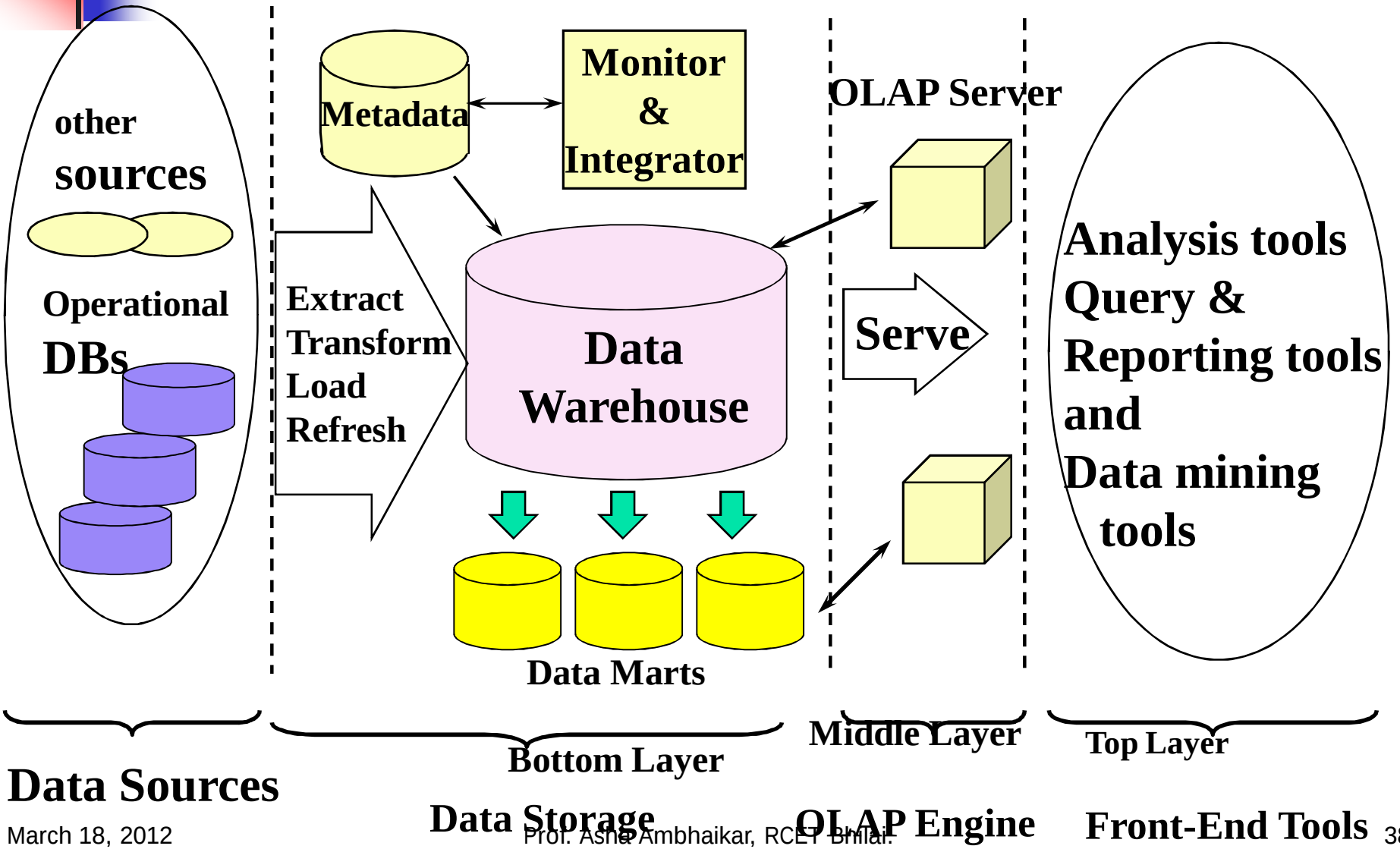
Basic Elements of a Data Warehouse

- Source System
- Staging Area
- Presentation Area
- End User Data Access Tools
- Metadata

Basic Elements of Data Warehouse



Data Warehouse Architecture



Working of Data Warehouse

Bottom Layer:

- The bottom layer is a DW database servers that is almost always a **relational database system**
- Data from **operational databases** and **external sources** are **extracted** using **application program** interfaces known as **gateways**
- It is supported by primary system

cont....

- It has repository that is **metadata** (data about data)
- Which is responsible for **extracting** the information from DW according to the queries given by the end users
- Metadata is the **bridge** between **DW** and the **DSS**
- It provides logical linkage between **data** and **application**
- Metadata can **pinpoint** access to information across the entire DW.

Middle Layer:

- The middle layer consists of **OLAP server**
- **OLAP** means **On Line Analytical Processing**
- It is **used** to **perform analysis** on **data** and **transform** it in to **useful information for decision making**
- OLAP is a continuously iterative process
- OLAP servers are implemented by either ROLAP,MOLAP or HOLAP

Cont..

TOP Layer:

- The top layer is a **client**
- That is the **end user**
- It consists of

1.query and reporting tools

2.Analysis tools and

3. Data Mining Tools

- It acts as an **interface** between the **user** and the **server**

Cont..

- This layer takes queries from the users
- And then send it to the servers
- Receiving information records back and
- Gives them as output to the end users.
- Eg. Analysis of weather forecasting, predictions and so on.

Principles of Dimensional Modeling

Multidimensional Data Model

- Collection of numeric measures, which depend on a set of dimensions.

– E.g., measure **Sales, dimensions**

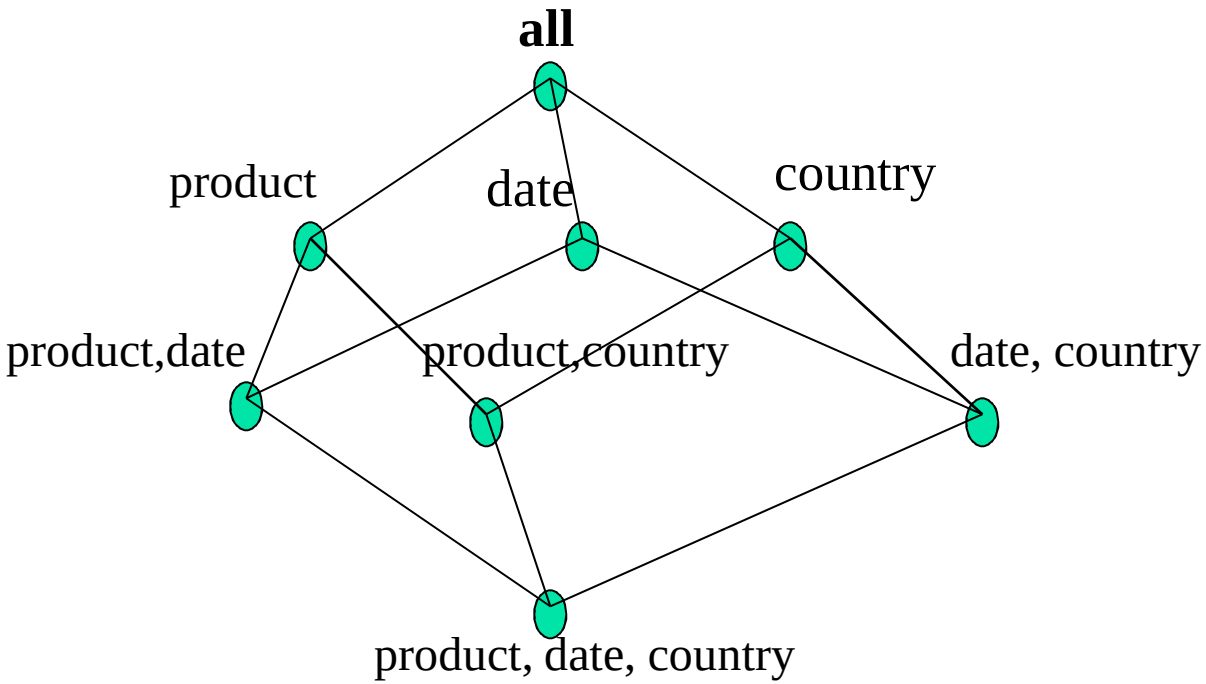
Product (key: pid), Location (locid)

and **Time (timeid).**

Multidimensional Data Models

- A data warehouse is based on a multidimensional data model which views **data in the form of a data cube**
- A data cube, such as sales, allows data to be modeled and viewed in multiple dimensions
  - Dimension tables, such as item (item_name, brand, type), or time(day, week, month, quarter, year)
  - Fact table contains measures (such as dollars_sold) and keys to each of the related dimension tables
- In data warehousing literature, an n-D base cube is called a **base cuboid.** The top most 0-D cuboid, which holds the highest-level of summarization, is called the **apex cuboid**. **The lattice of cuboids forms a data cube.**

Cuboids Corresponding to the Cube



0-D(apex) cuboid

1-D cuboids

2-D cuboids

3-D(base) cuboid

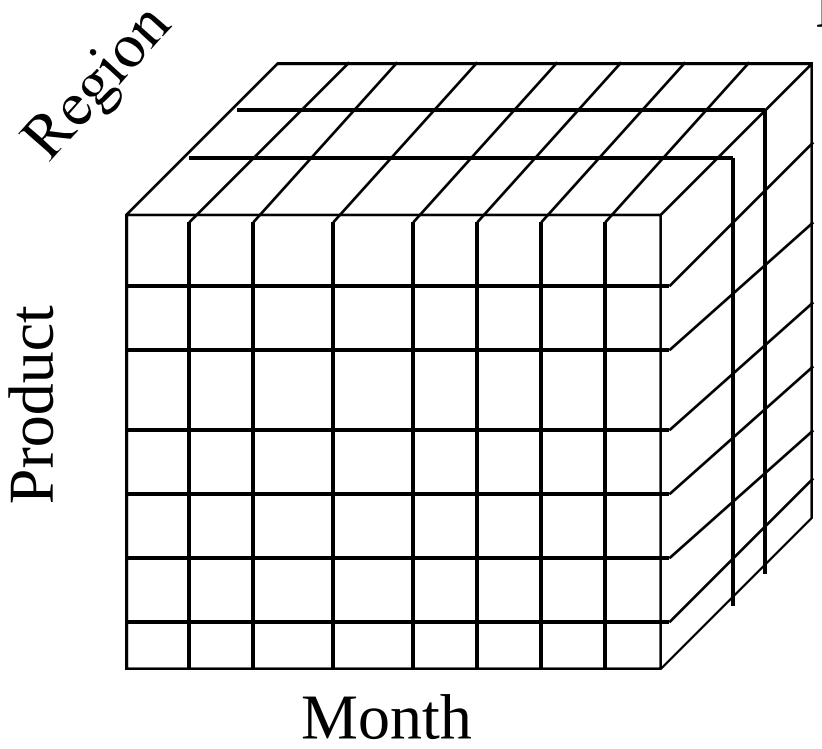
Multidimensionality

- **3-D + Spreadsheets (OLAP has this)**
- **Data can be organized the way managers like to see them, rather than the way that the system analysts do**
- **Different presentations of the *same data* can be arranged easily and quickly**

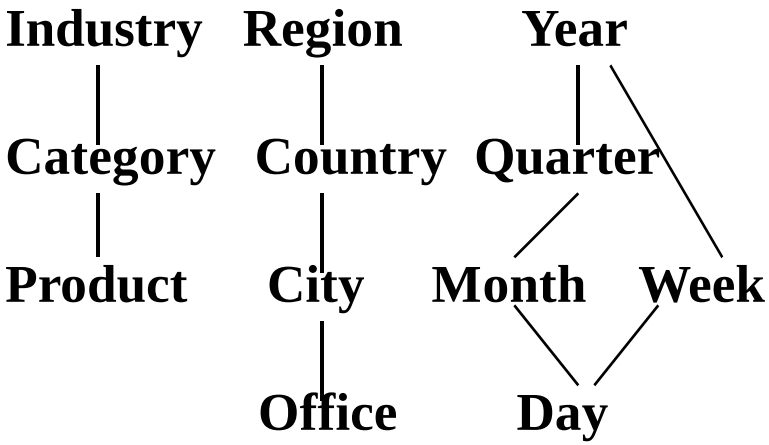
- ***Dimensions*: products, salespeople, market segments, business units, geographical locations, distribution channels, country, or industry**
- ***Measures*: money, sales volume, head count, inventory profit, actual versus forecast**
- ***Time*: daily, weekly, monthly, quarterly, or yearly**

Multidimensional Data

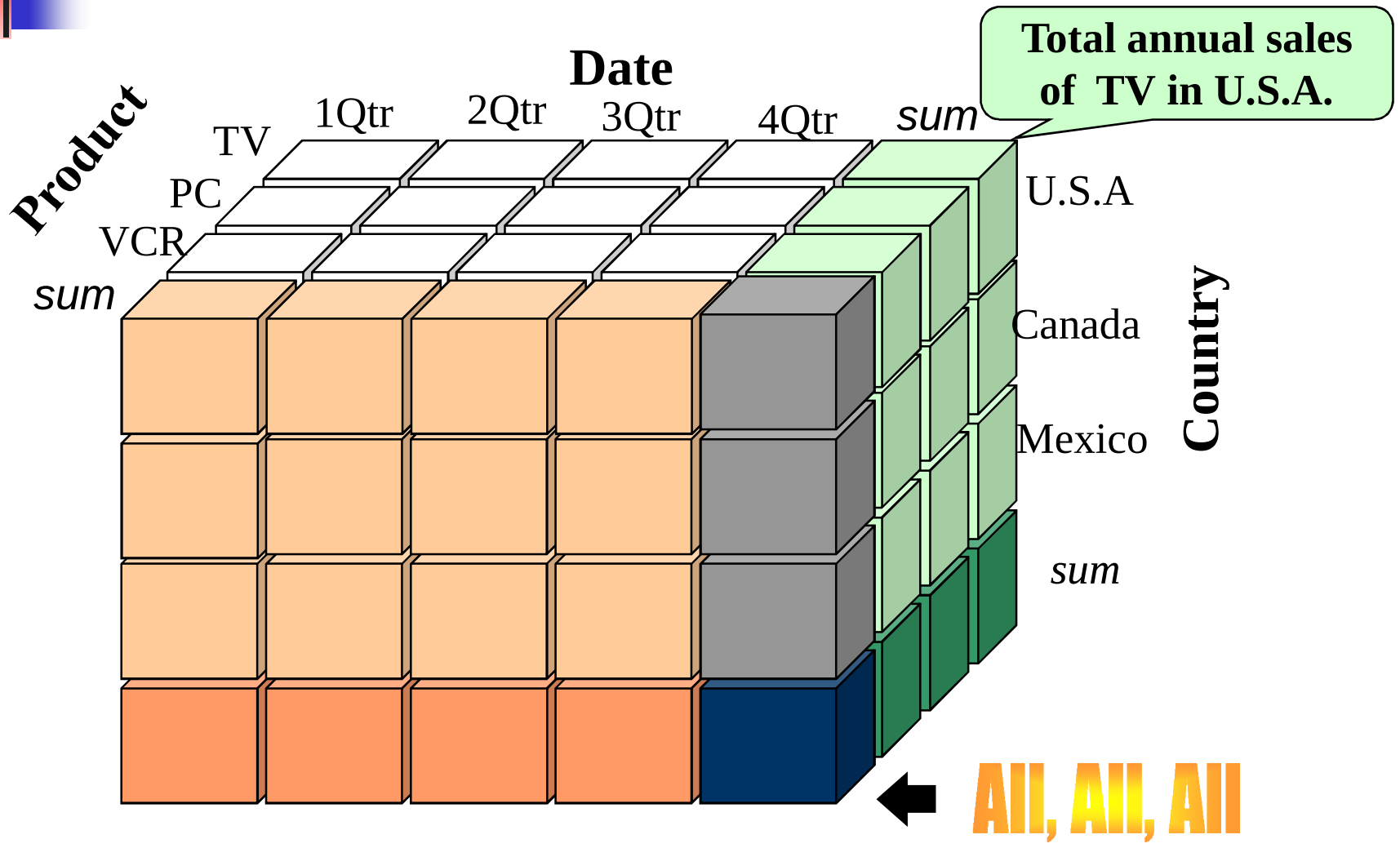
- Sales volume as a function of product, month, and region



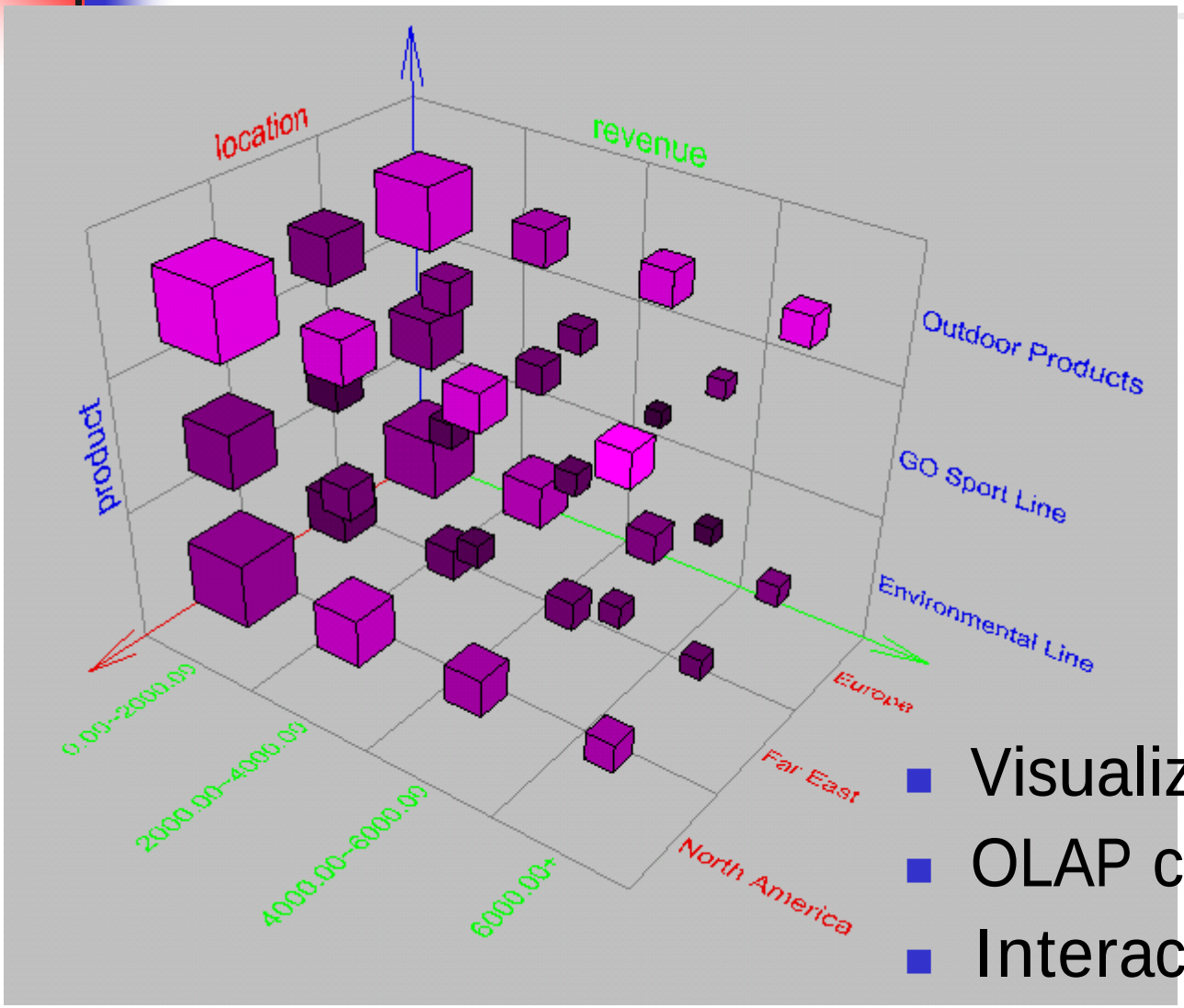
Dimensions: Product, Location, Time
Hierarchical summarization paths



A Sample Data Cube



Browsing a Data Cube



- Visualization
- OLAP capabilities
- Interactive manipulation

OLAP Operations

- OLAP means On Line Analytical Processing.
- It is used to **perform analysis on data** and **transform** it into **information** for decision making purpose.
- OLAP is a **continuous iterative process**.
- A common operation is to aggregate a measure over one or more dimensions.

– Find total sales.

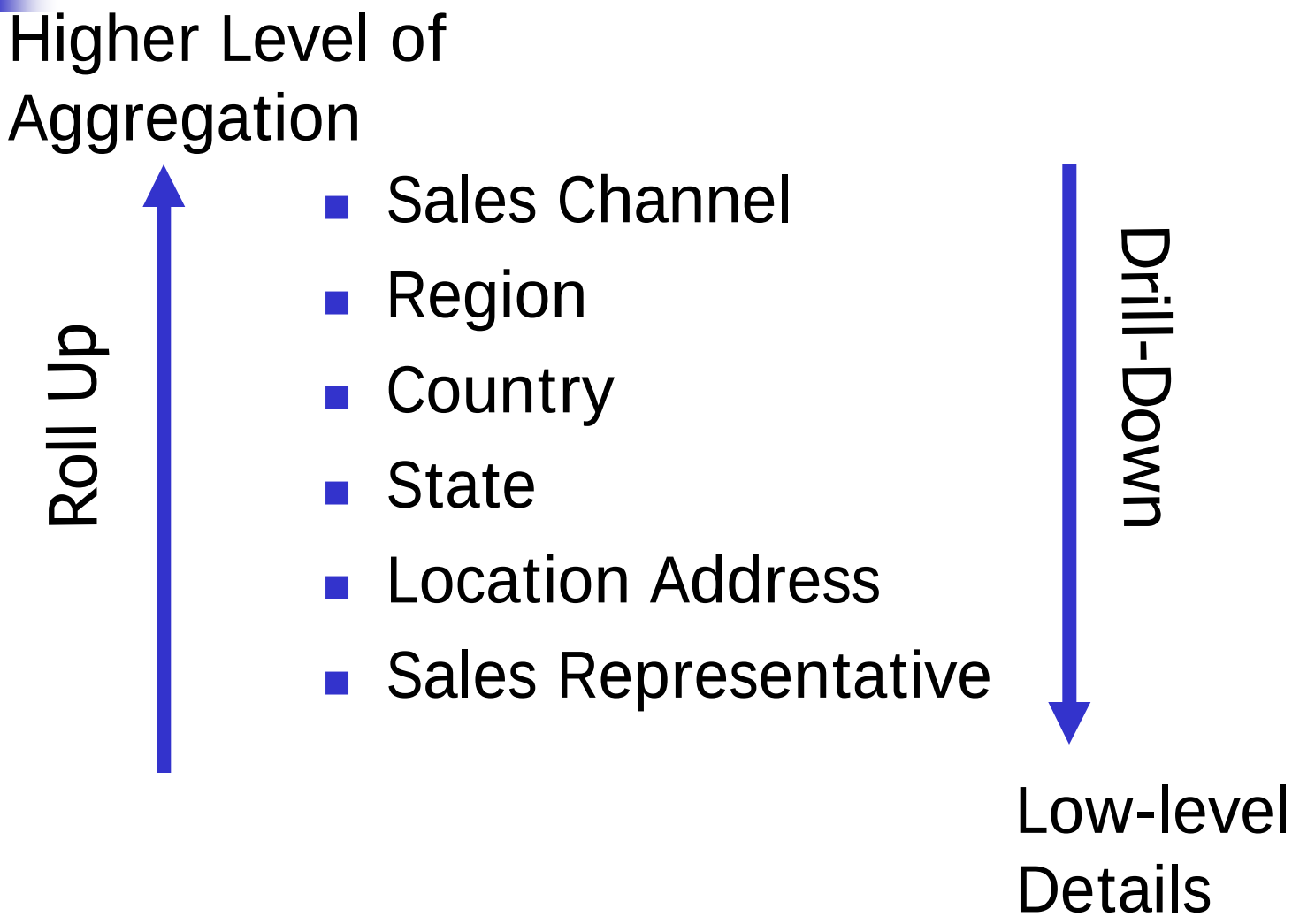
– Find total sales for each city, or for each state.

– Find top five products ranked by total sales.

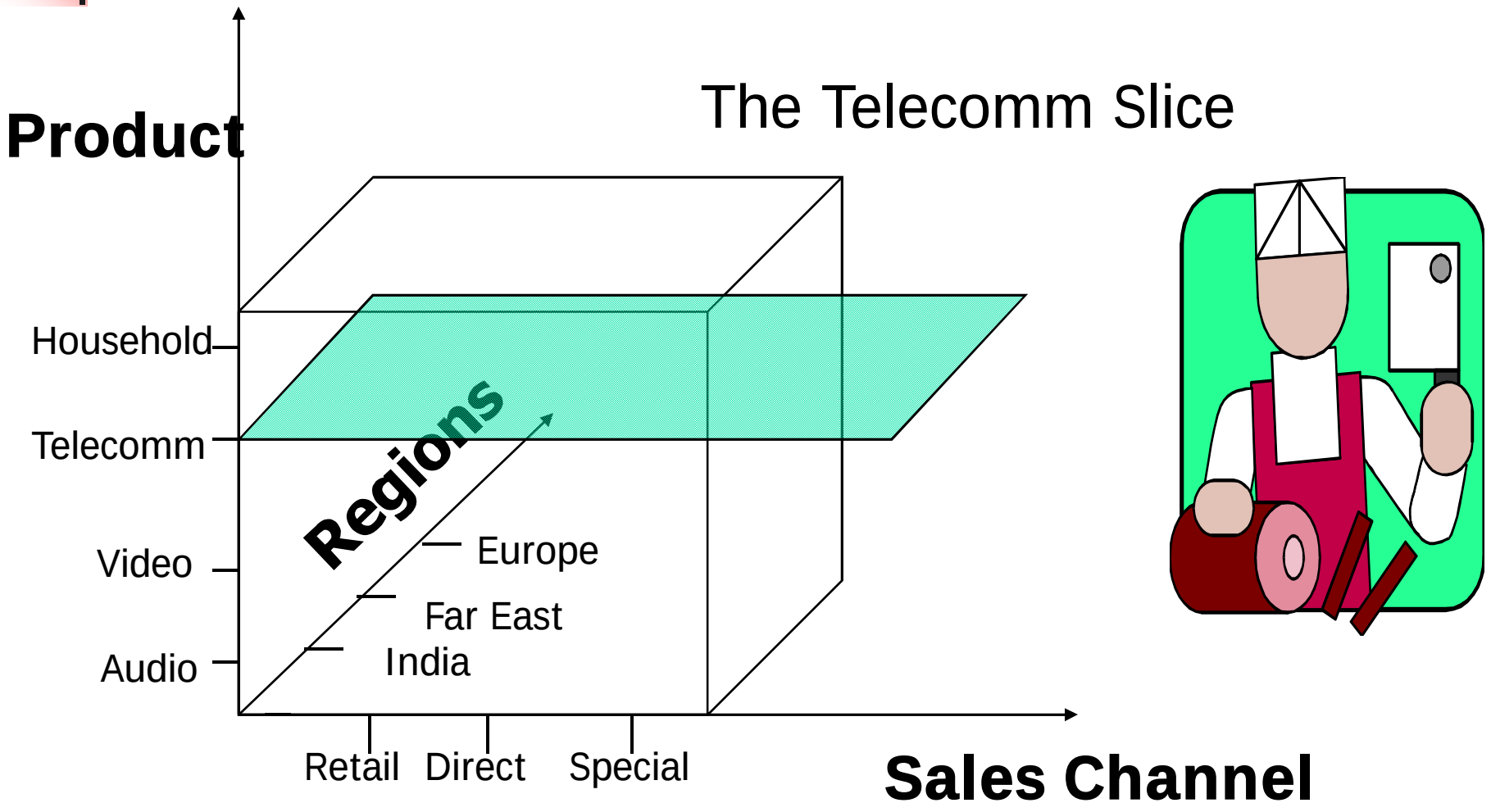
Typical OLAP Operations

- **Roll up (drill-up):** summarize data
- **Drill down (roll down):** reverse of roll-up
- **Slice and dice:**
  - project and select
- **Pivot :** rotate

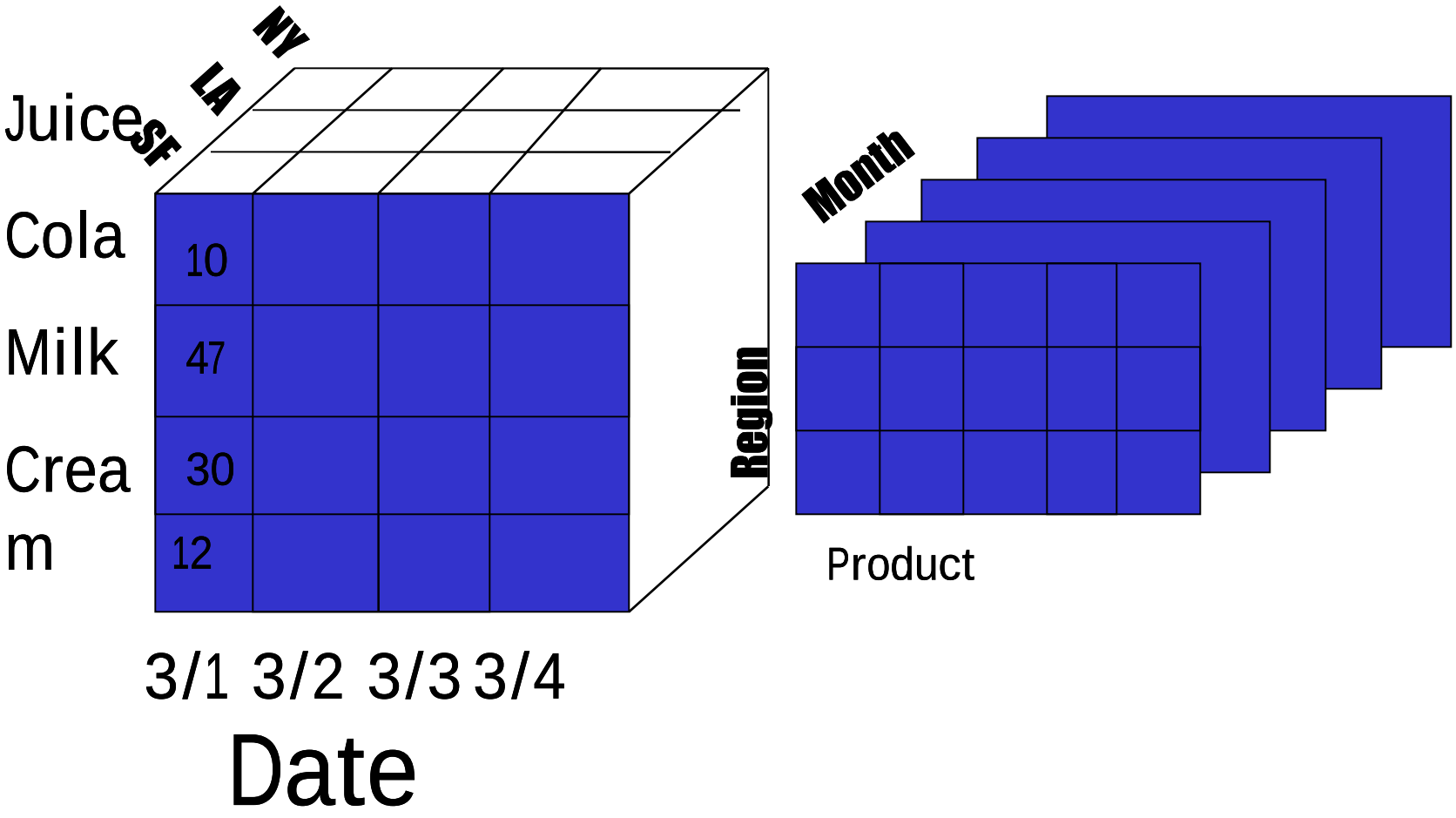
Roll-up and Drill Down



Slicing and Dicing



A Visual Operation: Pivot (Rotate)

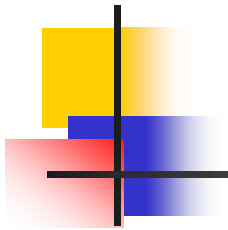


Typical OLAP Operations

- **Roll up (drill-up):** summarize data
  - by climbing up hierarchy or by dimension reduction
  - This operation performs aggregation on the data cube,either by climbing up a concept of hierarchy for a dimension or by dimension reduction.
  - When roll up is performed by dimension reduction, one or more dimensions are removed from the given cube.
- **Drill down (roll down):** reverse of roll-up
  - from higher level summary to lower level summary or detailed data, or introducing new dimensions
  - It navigates from less detailed data to more detailed data.
  - This can be realized by either stepping down a concept hierarchy for a dimension or introducing additional dimensions.

Cont.....

- **Slice and dice:**
  - project and select
  - The slice operation performs a selection on one dimension of the given cube resulting in a sub cube
  - The dice operation defines a sub cube by performing a selection on two or more dimensions
- **Pivot (rotate):**
  - It is visualization operation that rotates the data axes in new view in order to provide an alternative presentation of the data.
  - reorient the cube, visualization, 3D to series of 2D planes.



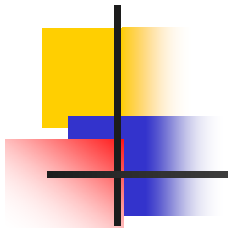
Cont.....

- Other operations
  - **drill across:** Executes queries involving (across) more than one fact table
  - **drill through:** Operation uses relational SQL facilities to drill through the bottom level of the data cube to its back-end relational tables

Physical Design Process

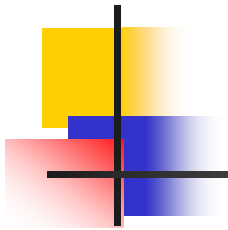
Stars, Snowflakes & fact Constellations:

- **Multidimensional model** can **exit** in the form of a **star schema, a Snowflake schema or a fact Constellation Schema**
  - **Star schema**: In star schema a data warehouse contains:
  - A **large central table** (**fact table**) containing the **bulk of the data** with **no redundancy**
  - a set of dimension tables one for each dimensions
  - **Snowflake schema**: A snowflake schema is a **refinement of the star schema**, where some **dimension tables are normalized** by **splitting the data** into **additional tables**.



Cont....

- The **difference between the snowflake and star schema model** is that the **dimension tables of the snowflake model can be kept in a normalized form to reduce redundancy.**
- **Fact constellations**: **Multiple fact tables share dimension tables**, viewed as a collection of stars, therefore called **galaxy schema** or fact constellation

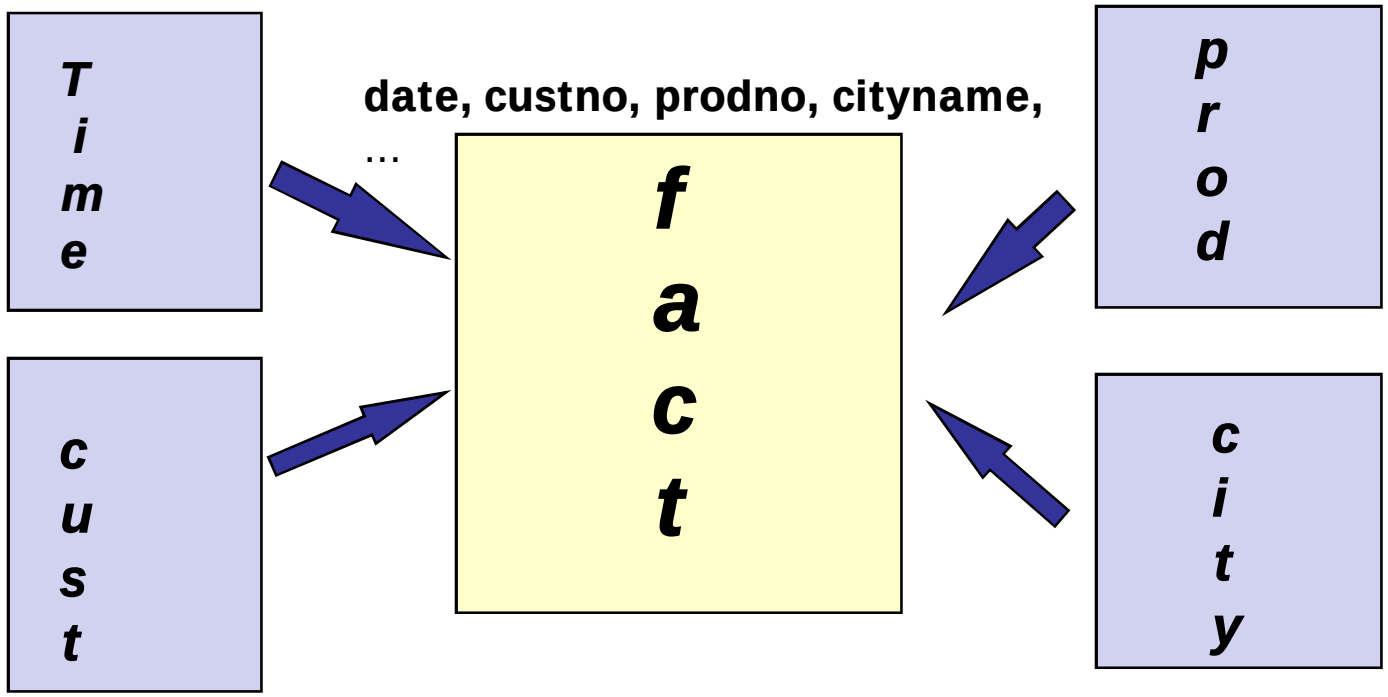


Fact Table

- Central table
  - mostly raw numeric items
  - narrow rows, a few columns at most
  - large number of rows (millions to a billion)
  - Access via dimensions

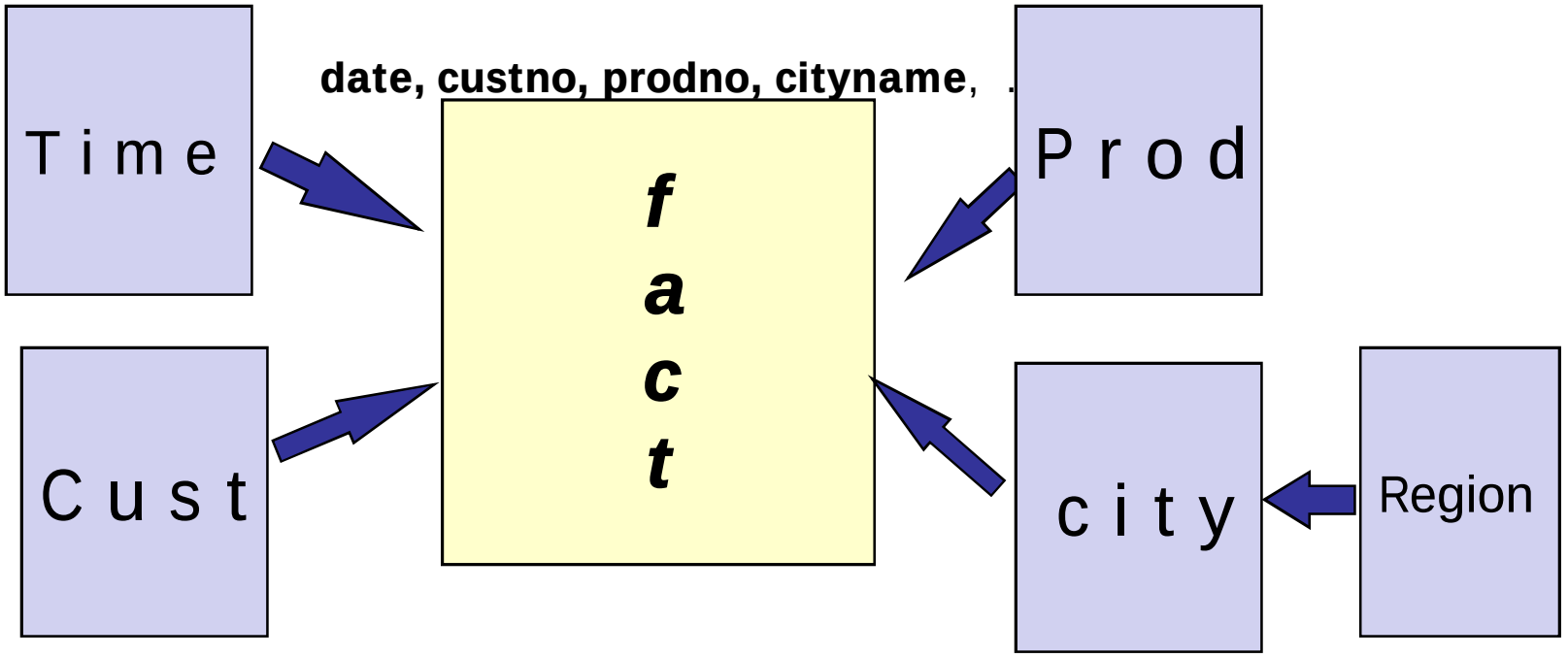
Star Schema

- A **single fact table** and for **each dimension one dimension table**
- **Does not capture hierarchies directly**

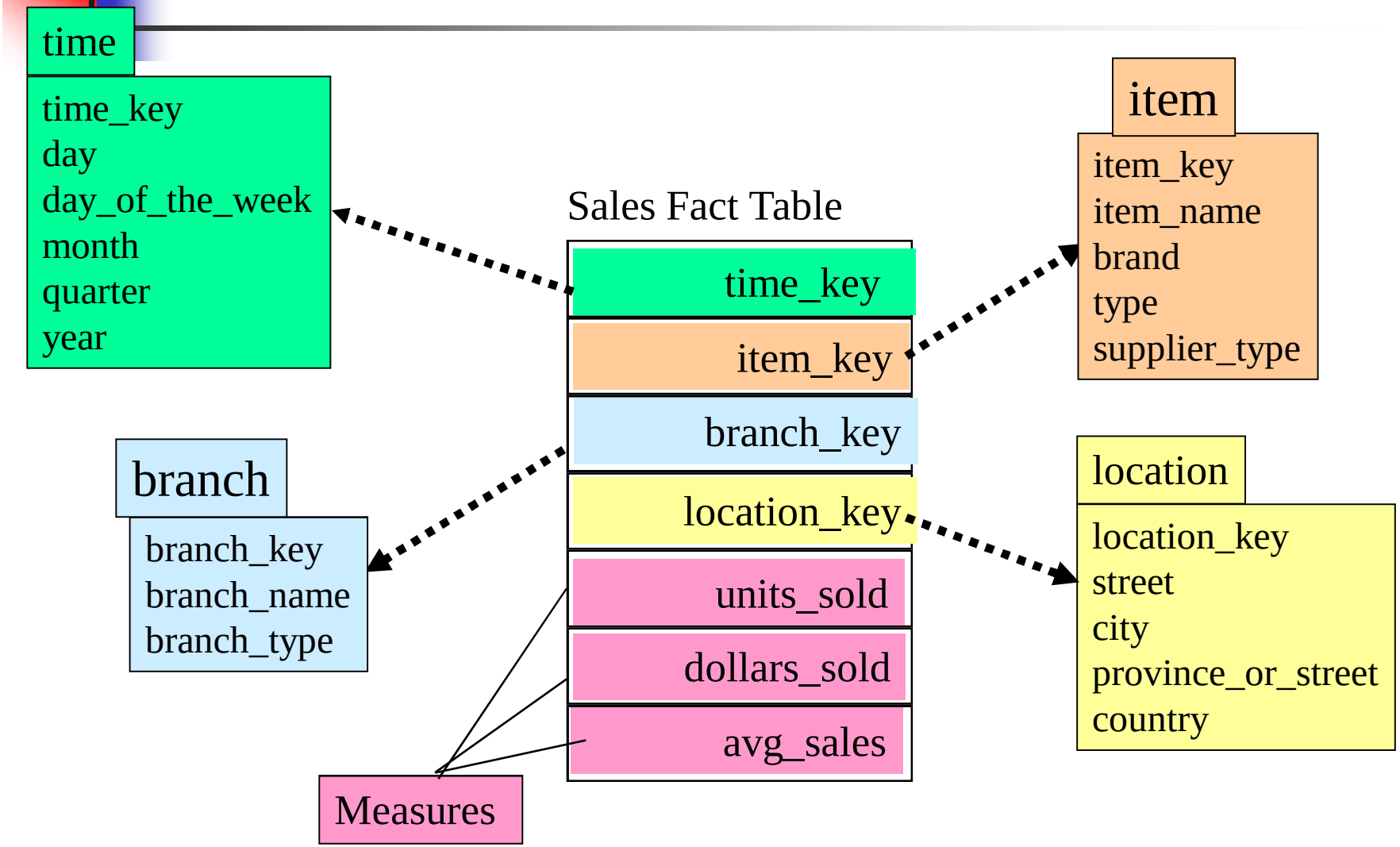


Snowflake schema

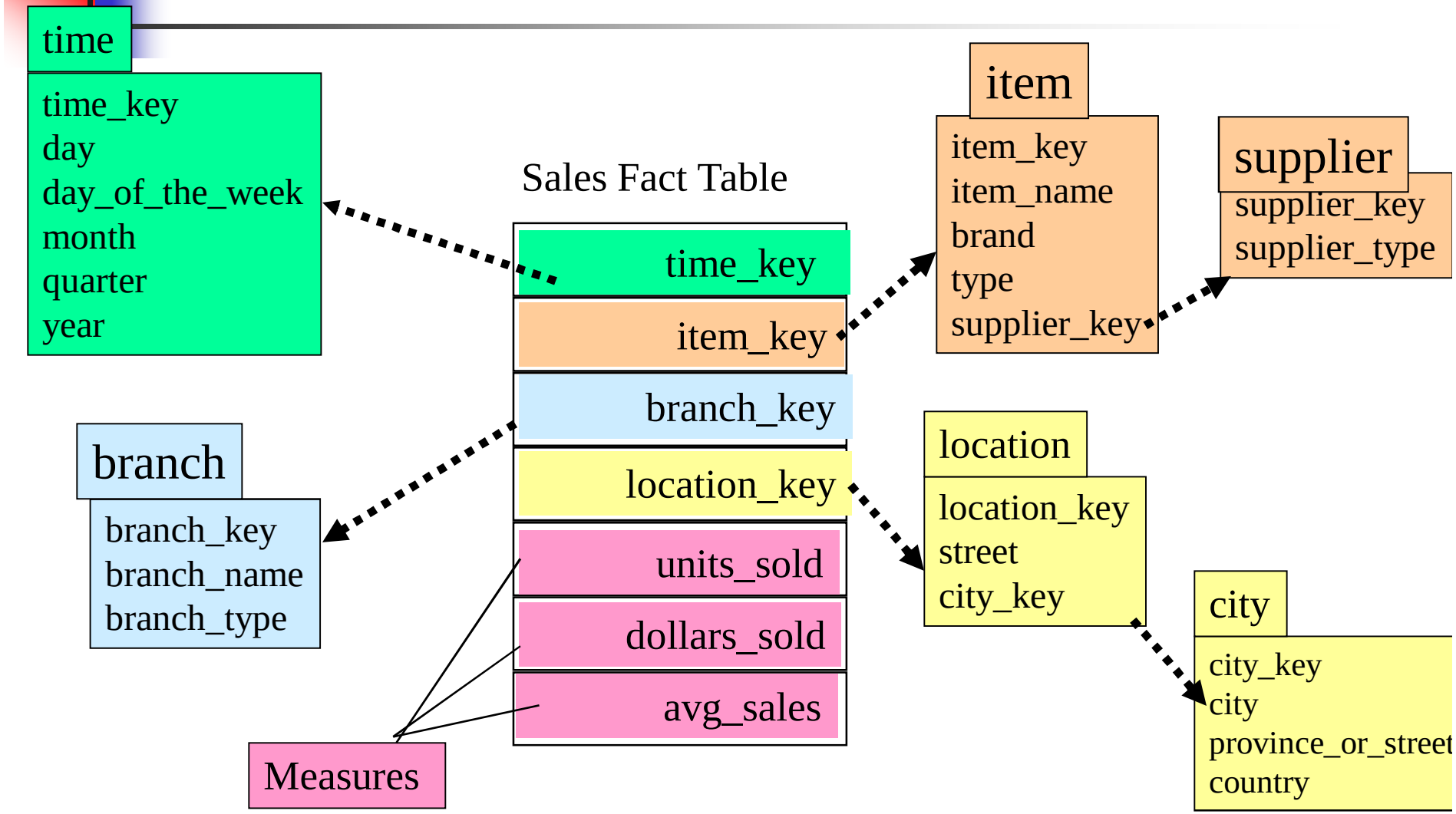
- Represent **dimensional hierarchy directly by normalizing tables.**
- Easy to maintain and saves storage



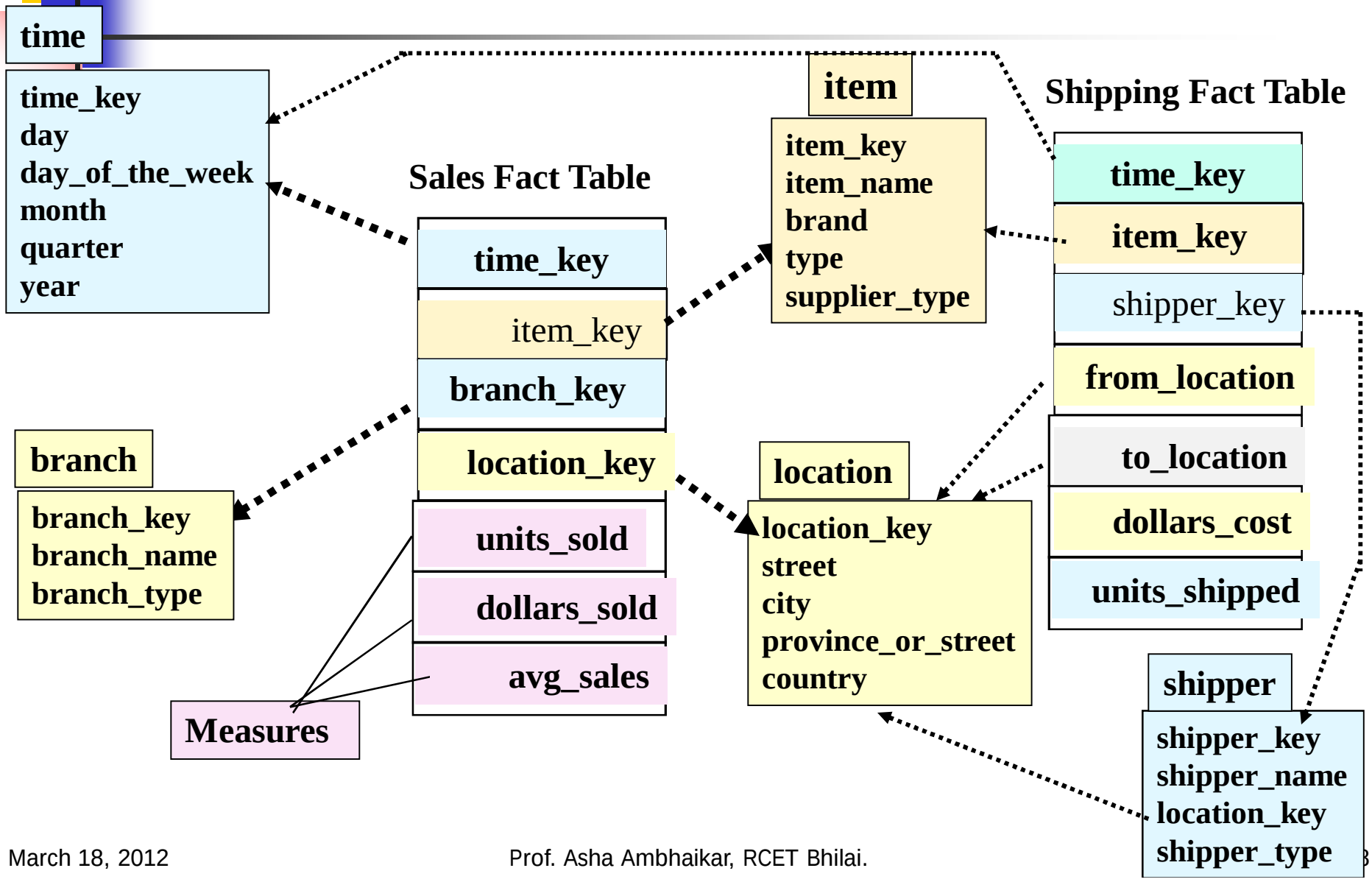
Example of Star Schema



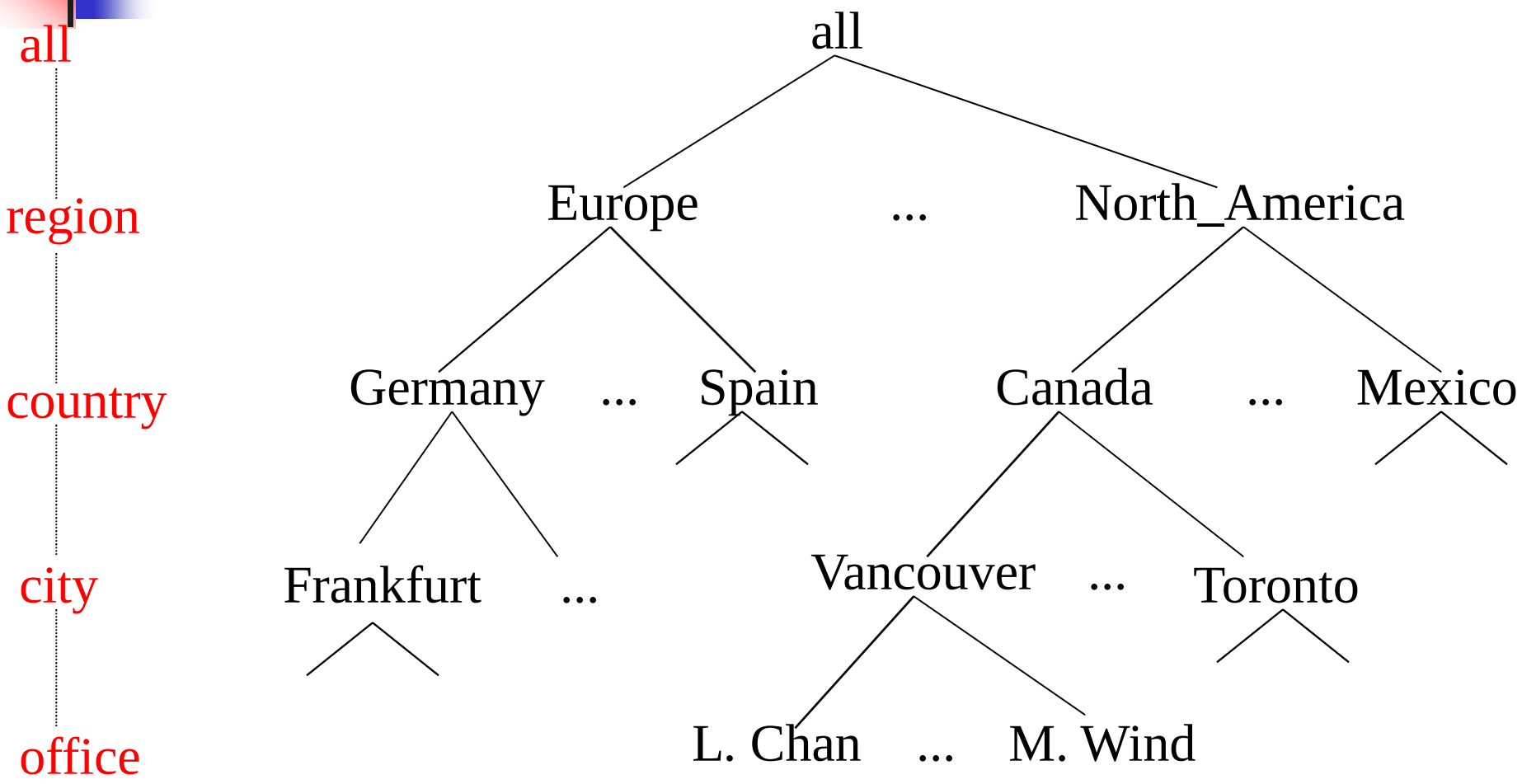
Example of Snowflake Schema

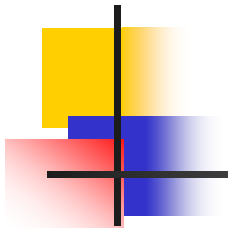


Example of Fact constellation



A Concept Hierarchy: Dimension (location)





OLAP Is FASMI

- **F**ast
- **A**nalysis to
- **S**hare
- **M**ultidimensional
- **I**nformation

Types of OLAP Servers

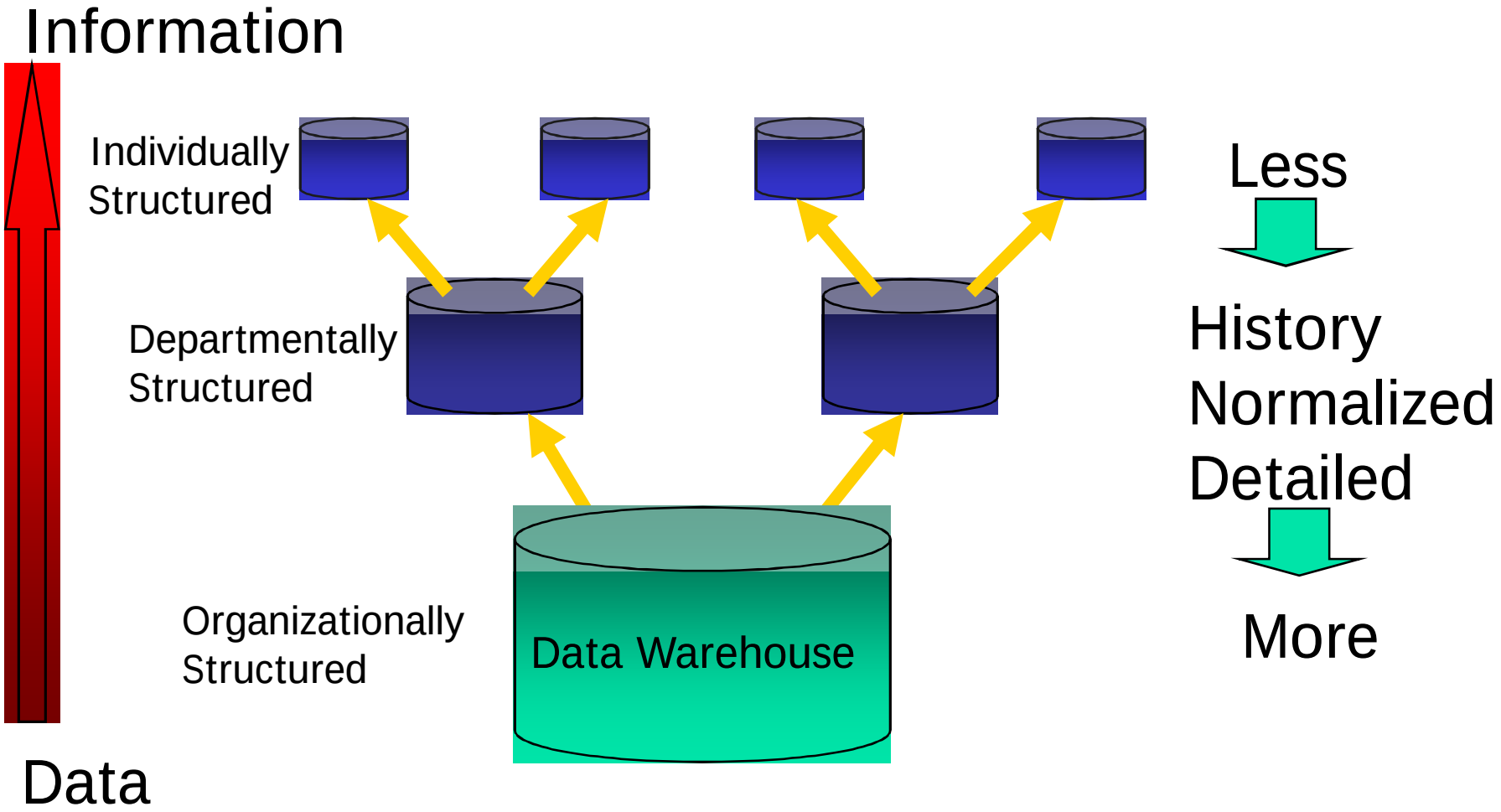
ROLAP SERVERS:

- **R**elational **O**n **L**ine **A**nalytical **P**rocessing are **intermediate servers** which lies between a **relational back end** server and **client front end** tools.
- They uses a relational DBMS to storage and manage data
- **ROLAP** servers support **multidimensional** views of data

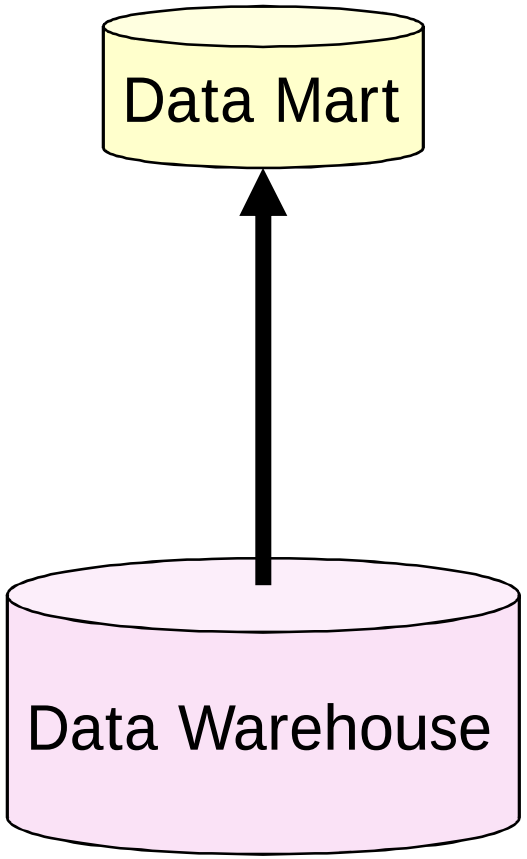
Cont...

- **Multidimensional OLAP (MOLAP) Servers**
  - These servers support multidimensional views of data
  - Array-based multidimensional storage engine
  - fast indexing to pre-computed summarized data
- **Hybrid OLAP (HOLAP)**
  - HOLAP is a combination of ROLAP and MOLAP
  - It for User flexibility, e.g., low level: relational, high-level: array
- **Specialized SQL servers**
  - specialized support for SQL queries over star/snowflake schemas

From the Data Warehouse to Data Marts



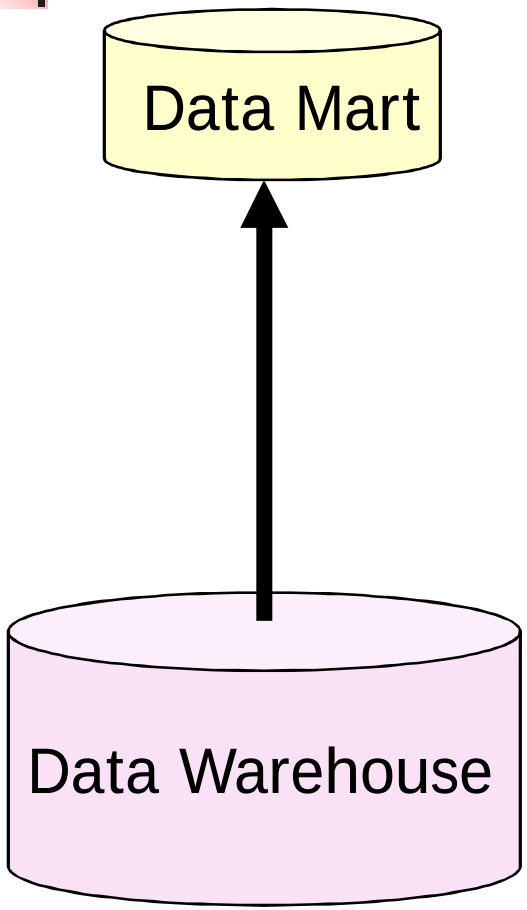
Data Warehouse and Data Marts



OLAP
Data Mart
Lightly summarized
Departmentally structured

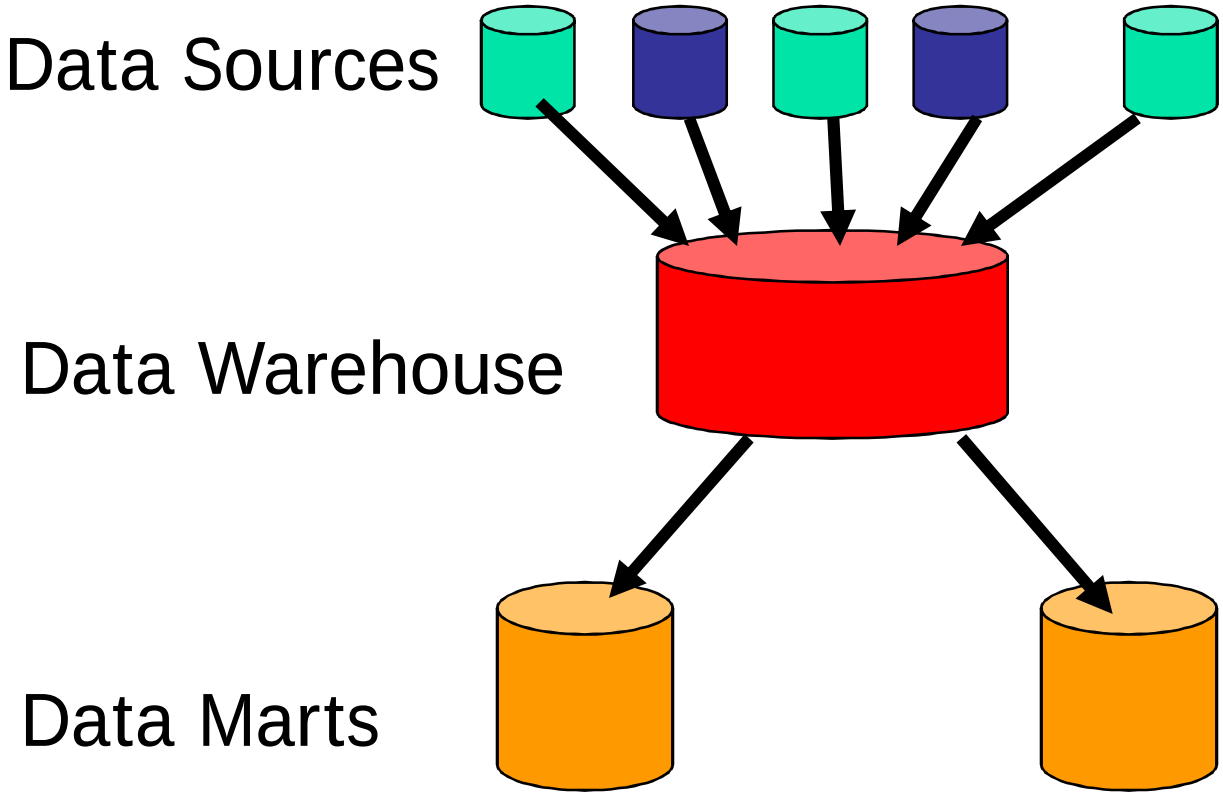
Organizationally structured
Atomic
Detailed Data Warehouse Data

Characteristics of the Departmental Data Mart



- Data Marts are the subset of DW.
- Data marts has OLAP
- It is smaller than data warehouse
- It contains information from a single department of a business or organization
- It is Flexible
- Customized by Department
- Source is departmentally structured data warehouse

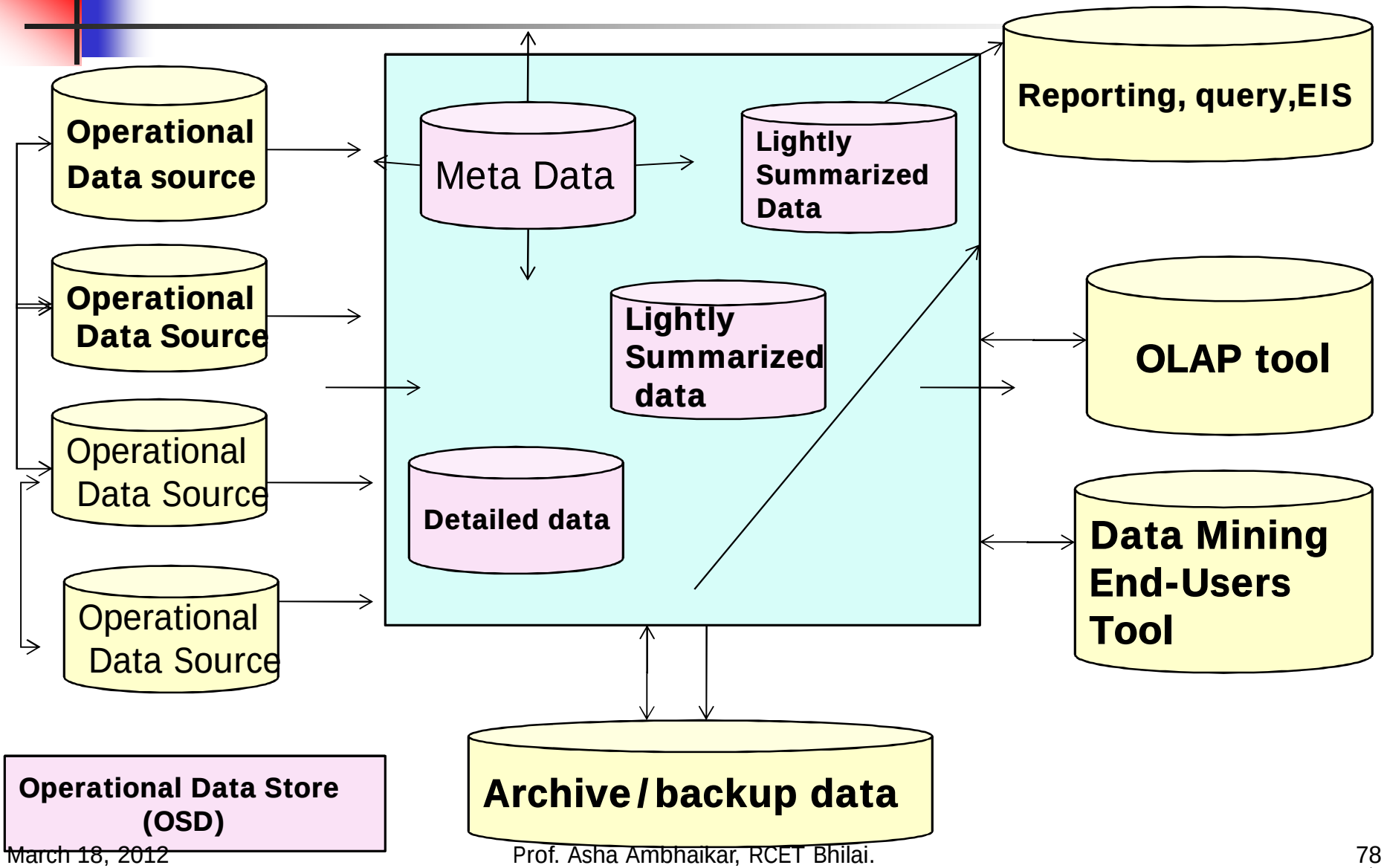
True Warehouse

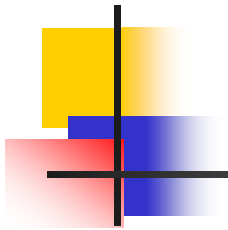


Data Warehouse Back-End Tools and Utilities (ETL Tool)

- **Data extraction**:
  - get data from multiple, heterogeneous, and external sources
- **Data cleaning:**
  - detect errors in the data and rectify them when possible
- **Data transformation:**
  - convert data from legacy or host format to warehouse format
- **Load:**
  - sort, summarize, consolidate, compute views, check integrity, and build indices and partitions
- **Refresh**
  - propagate the updates from the data sources to the warehouse

Components of Data Warehouse





Data Warehouse Components

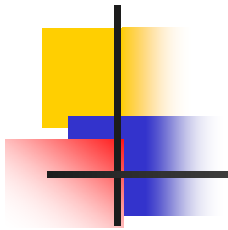
- Operational Data Sources
- Operational Data Store (ODS)
- Load Manager
- Warehouse Manager
- Query Manager

1.Operational Data Sources

- Operational Data sources for the DW is supplies from mainframe.
- Operational data held is first generation, hierarchical and network database.
- departmental data, private data from workstations, servers and external system such as internet.
- commercially available DB or DB associated with the organizations, suppliers or customers.

2. Operational Data Stores (ODS)

- Operational Data Store is a **repository of current and integrated operational data** used for **analysis**.
- It is often structured and supplied with data in the same way as the data warehouse.
- But in fact it simply act as a **staging area** for **data** to be **moved** in to **warehouse**.



3. Load Manager

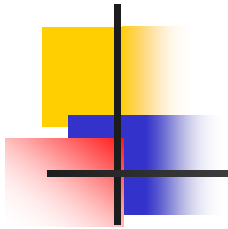
- Load Manager is called the backend component
- It performs all the **operations** associated with the **extraction** and **loading** of the data in to the **warehouse.**
- These operation includes **simple transformation of the data** to **prepare the data** for **entry** in to **warehouse.**

4. Warehouse Manager

- Warehouse Manager performs all the operations associated with the management of the data in the warehouse.
- The operation performed by the component includes
  - Analysis of the data to ensure consistency
  - Transformation and merging of source data
  - Creation of indexes and views
  - Archiving and backing-up of data

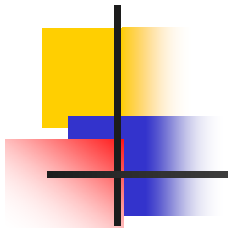
5. Query Manager

- Query Manager is also called front end tool
- It performs all the operation associated with the management of user queries.
- The operation performed by this component includes...
  - directing queries to the appropriate tables and scheduling the execution of queries.
  - Detailed, lightly and highly summarized data, archive/backup data.



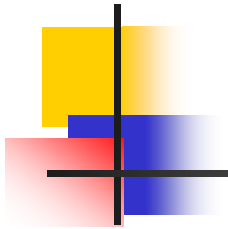
Cont…

- Metadata
- **End-user access tools:**
  - It can be categories in to five main groups
  1. Data reporting and query tools
  2. Application development tools
  3. Executive information System(EIS) tools
  4. Online Analytical Processing(OLAP) tools &
  5. Data Mining Tools



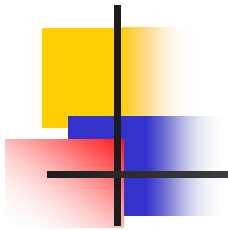
Data Flow

- **Inflow:** It is the process associated with the **extraction, cleaning and loading of the data** from the **source systems** in to the **warehouse.**
- **Up flow:** The process associated with **adding value to the data** in the **warehouse** through **summarizing, packaging and backing up** of **data** in the warehouse.



Cont…

- **Down Flow:** The process associated with archiving and backing up of data in the warehouse.
- **Out Flow:** The process associated with making the data available to the **end-users.**
- **Meta Flow:** The process associated with the management of the metadata.



Detailed Data

- It stores all the detailed data in the database schema.
- In most cases, the detailed data is not stored online but aggregated to the next level of detail.
- On regular basis, detailed data is added to the warehouse to supplement the aggregated data.

Lightly and Highly Summarized Data

- It stores all the pre defined lightly and highly aggregated data generated by the warehouse manager.
- Transient as it will be subject to change on a ongoing basis **in order to respond to changing query profiles.**
- The purpose of summary information is to....
  - **Speed up** the performance of queries.
  - **Removes** the requirement to continuously perform summary operations such as sort or group by in answering user queries.
  - The summary data is **updated** continuously as new data is loaded in to warehouse.

Archive / Backup Data

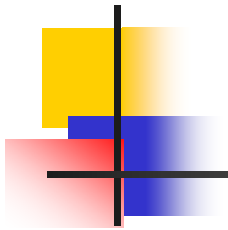
- It stores detailed and summarized data for the purpose of archiving and backup.
- May be necessary to backup online summary of data, if this data is kept beyond the retention period for detailed data.
- The data is transferred to storage archives such as magnetic tape or optical disk.

Meta data

- The area of the warehouse stores all the metadata(data about data) definitions used by all the processes in the warehouse.
- It is used for variety of purposes....
  - **Extraction and loading process**: Meta data is used to map data sources to common view of information with in the warehouse.
  - **Warehouse management process**: Meta data is used to automate the production of summary tables.
  - **Query management process:** Meta data is used to direct a query to the most appropriate data source.

End User Access Tools

- High performance is achieved by pre-planning the requirements for joins, summarizations and periodic reports by end-users.
- There are five main groups of access tools....
  - Data reporting and query tools
  - Application development tool
  - Executive Information System Tools
  - On line Analytical System(OLAP) Tools
  - Data Mining Tools.



Tools used for Data Warehouse

Most popular tools of DW are

- Informatica Tool
- Cognos Tool
- Business Intelligence Tool
  - EIS
  - DSS
  - OLAP
  - Multidimensional Analysis Tool

Client/Server Architecture

Most of the Application Programs have Three Major Layers

1. Presentation Layer
2. Application or Business logic Layer
3. Services layer

- **Presentation Layer:**
  - The topmost layer is the **Presentation Layer.**
  - It provides human/machine interaction(the user interface)
  - It handles input from the keyboard, mouse or other device and
  - Output from screen display.

Application or Business Logic Layer

- The middle layer is the **Application or business logic layer.**
- Application logic makes the difference between an order entry system and an inventory control system.
- It is often called business logic layer because it contains the business rules that drive a given enterprise.

Services layer

- The bottom layer is the **Services Layer**.
- This layer provides the generalized services needed by the other layers.
- Such as file services, print services, communication services and most important database services.

Architecture Models

- As a result of the limitations of file sharing architecture, the client/server architecture emerged as
  - **One-tire**
  - **Two tier**
  - **Three tier and**
  - **n- tier**

Cont…

- Architecture Model of data warehouse consist of **three programming layers**

1. Presentation layer
2. Business logic layer &
3. Services layer(such as databases)

- The number of tiers in a client/server application is determined by **how tightly or loosely the three program layers are integrated.**

One Tier Architecture

- A One Tier application is one in which three program layers are tightly connected.
- In One tier application the presentation layer, business logic and services are tightly integrated with in the single program.
- In this, the presentation layer has intimate and detailed knowledge of the database structure.
- The application layer is often interwoven with both the presentation and services layer
- All three layers, including the database engine, almost always run on the same computer.

One Tier Data warehouse

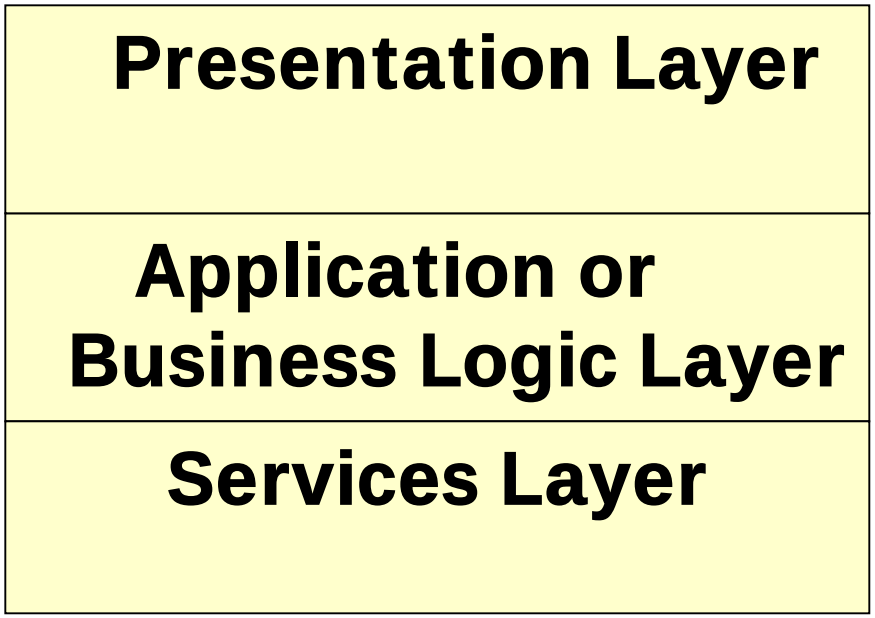
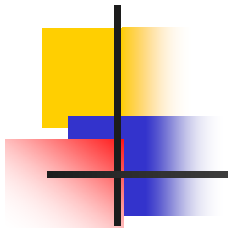


Fig.1 In one tier application the presentation layer, business logic and services are tightly integrated with in a single program



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- The most tools provides database engines that can handle one-tier designs such as Jet engines used with Access and VB.

Two Tier Architecture

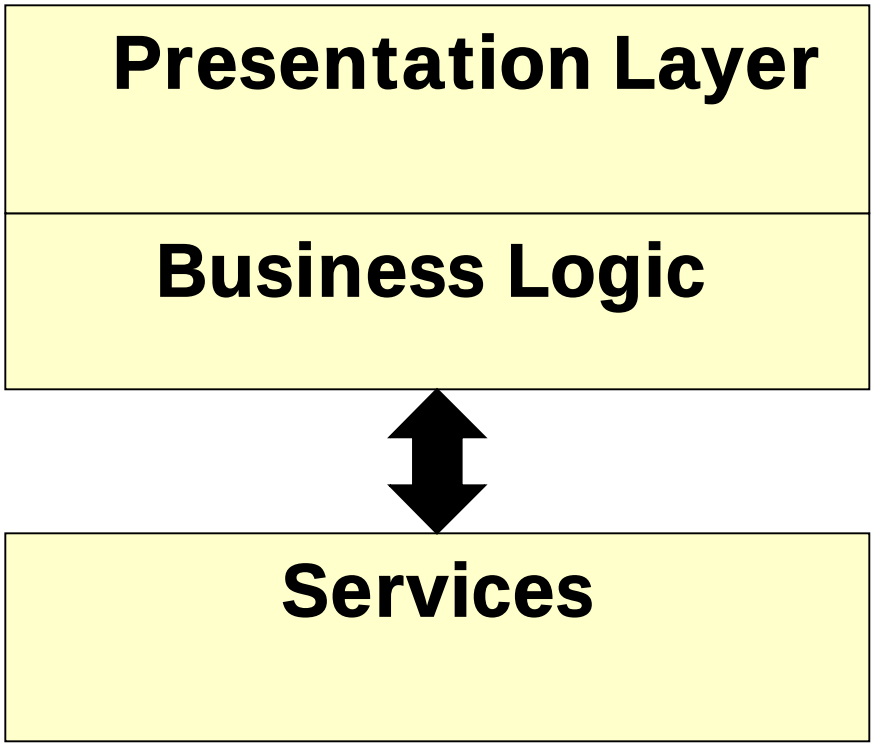
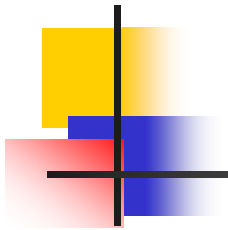
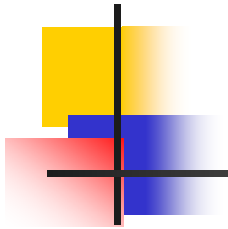


Fig.1 In two tier application when services detached from application or business logic , so that they can run independently



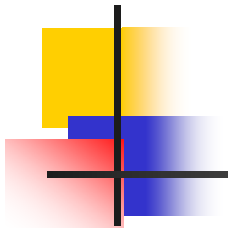
Two Tier Architecture

- When services are detached from an application or business logic layer, then the application becomes two tier.
- That means database services are separated from the application in two tier design.
- In this the presentation and business logic layer remains as it is i.e. combined and both continue to have intimate knowledge of database.



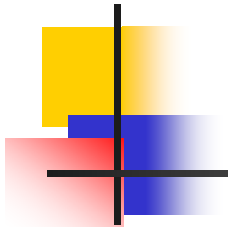
Cont...

- The two tier design allocates the user system interface exclusively to the client.
- It places database management on the server and splits the processing management between client and server creating two layers.
- Two-tier application requires separate database products such as Oracle, IB2, Sybase or Microsoft SQL Servers.



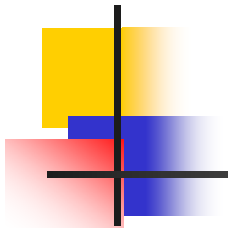
Cont...

- In two-tier client/server architecture ,the user system interface is located in the users desktop environment and the database management services are usually in server that is most powerful m/c that services many clients.



Benefits

- The two tier architecture improves flexibility and scalability by allocating the two tier over the computer network.
- Two tier improves usability because it makes it easier to provide a customized user system interface.
- The two tier client server architecture is a good solution for distributed computing when work groups are dozens to 100 people interfacing on a LAN simulteneously.



Limitations

- When the number of users exceeds 100, performance begins to deteriorate.
- There is limited flexibility in moving (repartitioning) program functionality from one server to another

Three Tier Architecture

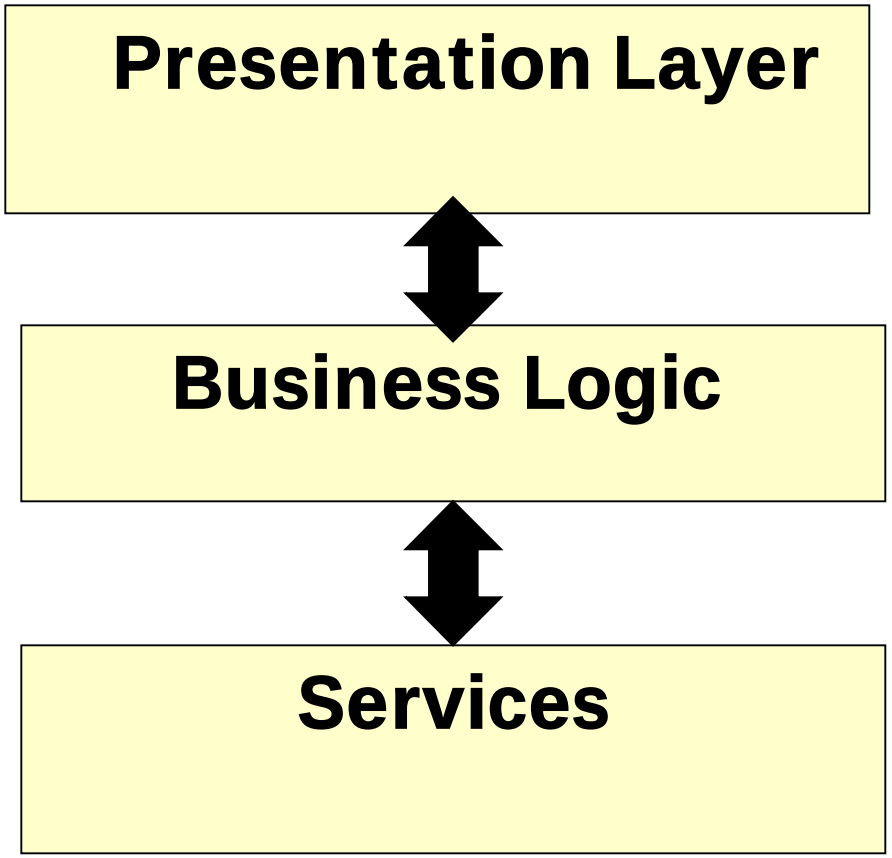
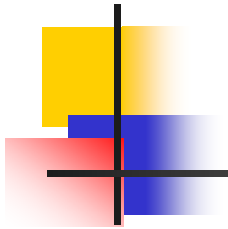


Fig.1 In three tier application when business logic layer becomes independent of the presentation layer and services



Cont...

- The three-tier software architecture introduced in 1990s to overcome the limitations of the two tier architecture.
- The third tier (middle tier server) is between the user interface (client) and the data management (server) components.
- In three-tier designs, the **business logic** itself **becomes a service**.
- And that service can also be run on its own computer and is called as **application server**.

Cont...

- There are variety of ways for implementing this middle tier, such as transaction processing monitors, message server or application server.
- This middle tier can perform
  - Queuing
  - Application execution and
  - Database staging
- In three-tier presentation layer usually does not have intimate knowledge of the database .
- Hence presentation layer communicates with its application server using a predefined message strategy.

Cont...

The three tier architecture is introduced to improve performance for groups with a large number of users (in the thousands) and improves flexibility as compared to two-tier.

- The three tier architecture is used when an **effective distributed client/server design** is needed that provides increased **performance, flexibility, maintainability, reusability and scalability** while hiding the complexity of distributed processing from user.
- These characteristics have made three-tier architectures a popular choice for Internet application.

Data Warehouse Usage

- Three kinds of data warehouse applications
  - **Information processing**
    - supports querying, basic statistical **analysis, and reporting using crosstabs, tables, charts and graphs**
  - **Analytical processing**
    - **multidimensional analysis of data warehouse data**
    - 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.

Summary

- **Data warehouse**
  - A subject-oriented, integrated, time-variant, and nonvolatile collection of data in support of management's decision-making process
- **A multi-dimensional model** of a data warehouse
  - Star schema, snowflake schema, fact constellations
  - A data cube consists of dimensions & measures
- **OLAP operations**: drilling, rolling, slicing, dicing and pivoting
- **OLAP servers:** ROLAP, MOLAP, HOLAP

Important Questions on DW

- What is Data Warehouse? Explain in detail.
- Draw and explain the Data Warehouse Architecture.
- Explain Data warehouse component with suitable diagram.
- What is OLAP? Explain OLAP operations along with its types.
- Explain Star Schema and snowflake Schema.
- What is multidimensional data model? Explain with neat diagram.
- Compare the OLTP and OLAP.