

(Big) Data Engineering In Depth

From Beginner to Professional

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The Definitive Guide to Big Data Engineering Tasks

Chapter: Introduction To Data Management and Data Warehouse

Chapter Objectives

- Be familiar with data management life-cycle.



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- Understand the data abstraction and the data layer.



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- What are the data modeling and its design?



Section: Data Management

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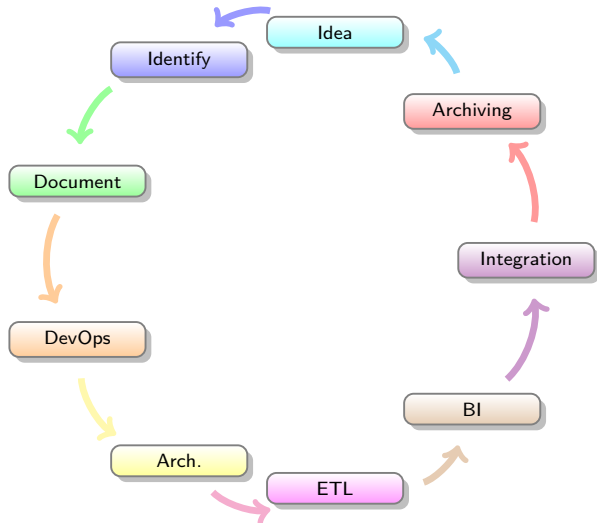


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 - Data retention or **archiving** process ex: (Hot or Cold storage).



Data Management Life-Cycle



Section: Data Abstraction



Motivation to Data Layers (Use Case)

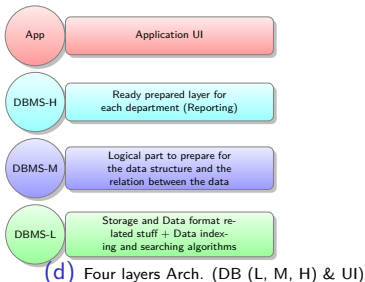
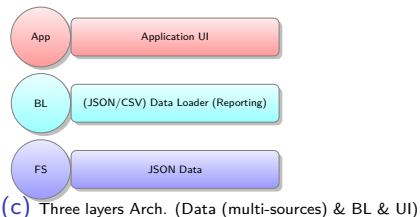
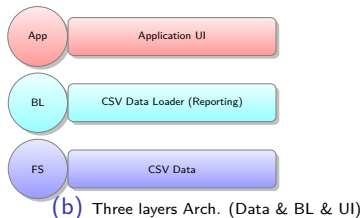
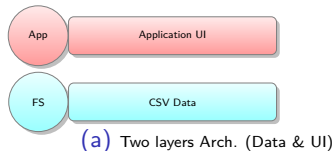


Figure: Data Abstraction Journey

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- To answer these questions you need to understand the **data layers**.



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- The process of hiding irrelevant details from the developer (user) is called data abstraction.



Data Layers (Abstraction)

Definition

Data Abstraction and Data Independence: DBMS comprises complex data-structures. To make the system efficient in terms of retrieval of data and reduce complexity in terms of usability of users, developers use abstraction i.e., hide irrelevant details from the users. This approach simplifies database design.

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 - Physical Level
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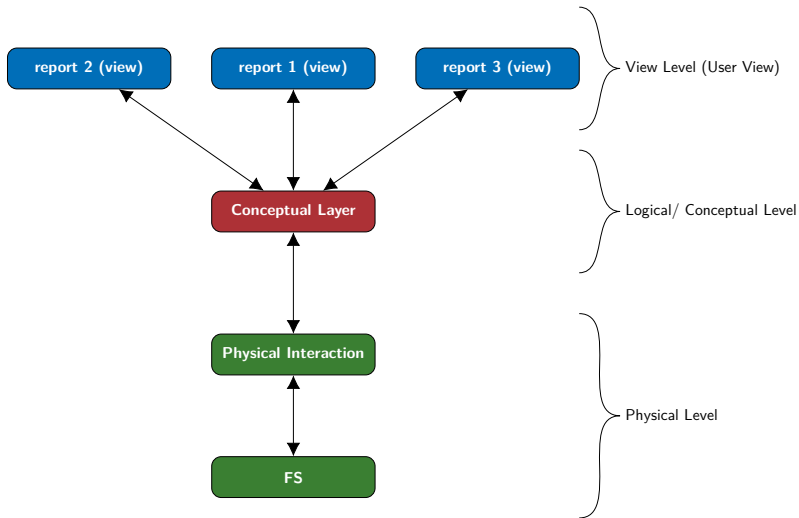
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 - Physical Level
 - Logical/Conceptual Level.
 - View Level.



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- Extended or hidden based on the user's role
- Not all the views is extended to all users, and there is authentication based on the category



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- We might hide information about some products based on the teams or users

Data solution thinking (Summary)

Let's answer our previous question. How can we solve data challenges?



Data solution thinking (Summary)

- Let's split the problem based on the data layers.



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 - Update the data type or the existing relation, which could help to fix some data or performance issues.



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 - If we need to change the data orientation structure from row to column or key-value storage, It is time to change the physical layer.



Section: Introduction to DWH

Sub-Section: Motivation to Data Warehouse (DWH)



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- Reporting the results after passing the data life-cycle will be from storage (Database).
- There are some challenges facing the people who work on data management backend:
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 - Integration.
 - Applying analytical functions.
- Vendors who are working to solve the above challenges creating their own product of DWH and their ultimate work is to optimize the above points.



Motivation to Data Warehouse (DWH)

Definition (What is Data Warehousing?)

A DWH is defined as a technique for collecting and managing data from varied sources to **provide meaningful business insights**. It is a blend of technologies and components which aids the strategic use of data.

The real concept was given by Inmon Bill. He was considered as a father of the DWH. He had written about a variety of topics for building, usage, and maintenance of the warehouse & the Corporate Information Factory



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- The DWH is the core of the BI system which is built for data analysis and reporting.



Motivation to Data Warehouse

Data warehouse system is also known by the following names:

- Decision Support System (DSS).
- Business Intelligence Solution.
- Executive Information System.
- Management Information System.
- Analytic Application.
- Data Warehouse.



Sub-Section: Differences Between DWH and Operational DB

DWH vs Operational databases

Metric	Transactions DB	DWH
Volume	GB/TB	TB/PB
Historical rows	Short-term <1000M	Long-Term 1000M>
Orientation	Product	Subject or multi products
Business Units	Product team	Multi organizational units
Normalization	Normalized	Not required (De-normalized in many use cases)
Data Model	Relational	Star Schema or Multi-dim
Intelligence	Reporting	Advanced reporting and Machine Learning
Use cases	Online transactions & operations	Centralized storage (360°)



Transnational DB Use cases



Transnational DB Use cases







DWH Use cases



Sub-Section: Types of DWH



Motivation to Data Warehouse

Types of Data Warehouse

Enterprise Data Warehouse (EDWH) It provides decision support service across the enterprise. It offers a unified approach for organizing and representing data (DWH Model). It offers data classifications according to the subject with privileges policy.

Operational Data Store (ODS): is a central database that provides an up-to-date (real-time) data from multiple transnational systems for operational reporting into a single DWH.

Data Mart: A data mart is a subset of the data warehouse. It specially designed for a particular line of business, such as sales, finance, sales or finance. In an independent data mart, data can collect directly from sources.



DWH vs ODS vs Data Mart

Metric	DWH	ODS	Data Mart
Latency	Day -1	Real-time	Day -1
Data level	Transnational	Transnational	Summary
Historical	Long-term	Snapshot	Aggregated Long-Term
Size	TB/PB	GB	GB/TB
Orientation	Multi sources	Multi sources	Product
Business Units	Multi organizational units	Product team	Business team

Sub-Section: Use Cases of Operational DB vs DWH



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 - This system has a backend database (MySQL).
 - CRM team can report their sales and customer activities from their database.



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- A telecommunication company named **XTec**.
- They have lots of systems. One of this systems is a CRM system as example of operational DB.
 - The CRM system handles the customer activities with the company including (sales, change in customer plans, and other activities).
 - This system has a backend database (MySQL).
 - CRM team can report their sales and customer activities from their database.
 - Product owner can take a decision based on their system backend reports.



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 - So, they need to ingest (transfer) the data from the source systems to one single database.
 - The decision from the DHW is a **global and strategical decision**.
 - If the company needs to build a machine learning model which needs data from different sources. They need to load the data from a centralized database rather than read each source alone.



Use case (DWH)

The Full picture required a DWH. However, we still need the other operational databases for product development perspective.



Use case (ODS)

- Why do we need the ODS?



Use case (ODS)

- Why do we need the ODS?
- How does it fit in our system?



Use case (ODS)

XTec has a call center system which handles the customer inquiries.

This system requires the some data related to usage, customer information, billing details to be calculated and accumulated in **real-time** to be able to give the customer the right answer for his inquires.



Use case (ODS)

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- So, What is the challenge for this system?
 - It needs specific information from different source systems.
 - It requires to track the source system database changes or update in real-time.
 - It's functionality is based on the aggregate data not the transactions for example (It needs the total outgoing calls till time or it needs the total charging amounts from prepaid or the available limits from billing if it is postpaid).



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- ODS is based on change data capture (CDC). This approach used to determine the data change and apply action based on this change.
- ODS uses the real-time aggregations to support the online systems from different source systems.



Section: DWH Characteristics



DWH Characteristics

- The characteristics of DWH:
 - Integrated: *DWH is an integrated environment which allows us to integrate different source systems. Data are modeled (organized) into a unified manner.*
 - Time-Variant: *Data modeled (organized) based on time periods (hourly, daily, weekly, monthly, quarterly, yearly, etc.)*
 - Subject-oriented: *DWH main target is to support business needs for the whole organization including (decision makers, departments, and specific user requirements).*
 - Non-Volatile: *It refers to the data will not erased or deleted (It could be archived and retrieved when needed). Data can be accumulated daily the new snapshots (refreshed at based on the source system interval. For example, It could be updated daily, weekly, and monthly).*



Section: Hot vs Cold Storage



Hot vs Cold Storage

SOME DETAILS HERE



Section: DWH Architecture



DWH Architecture Layers

- DWH Architecture contains the following layers:
 - Source system layer.



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 - Source system layer.
 - Extraction layer.



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 - System operations layer.



DWH Architecture Overview

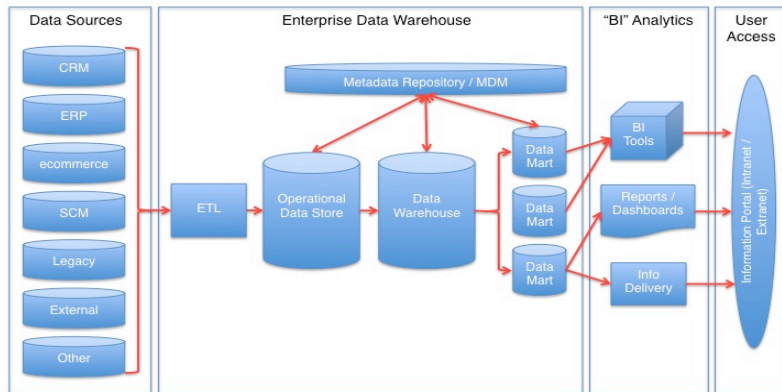


Figure: taken from

Sub-Section: Source System Integration Process



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 - All tasks should be clear what is the expected output for example (analysis means to document data structure, format, column names, etc..).



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- This layer deliver a data analysis (Source system interface) document.



Sub-Section: Extraction Layer



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 - Data size and format compared with the available resources for this project.
- This layer output is a minimal data cleansing (no transformation) into the staging/landing layer.



Sub-Section: Staging Layer



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Sub-Section: Data Modeling



Data Modeling Objective

- Understanding the data modeling and its roles.



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- Explore different types of data modeling.
- We will not go in details about how to design in this part (we will explain it later and in the appendix).



What is data model?

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- It refers to a set of concepts used in defining such as entities, attributes, relations, or tables.



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- It could be engage with any source systems integration from early stages.
- This stage output is data model design document or mapping sheet.



Why does data models are important?

- Data models are currently affecting software design.
- It decides how engineers will think about the problem they are solving.



Data Model Design vs Implementation

REVIEW THIS EXAMPLE

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- What do we do for the implementation?
 - Hire a contractor to build (implement the design) the home.
 - This phase will implement the design but it also include some detail related to the actual way to build the tools and the material. (Physical Design)



Data Model Design Principle

Decide what is the limitation of this part what is in and what is out to be part of the appendix

- facts, start schema, dimensional modeling techniques.
- Fact Tables and Dimension Tables.
- Multidimensional Model(Star, Snowflake, and Galaxy Schema).
- Support Roll Up, Drill Down, and Pivot Analysis
- Time Phased / Temporal Data
- Operational Logical and Physical Data Models
- Normalization and Denormalization
- Model Granularity : Level of Detail



Sub-Section: ETL Process



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- This team takes the delivered output from the previous stage (data modeling) and start to implement the mapping.
- The implementation of the ETL preferred to be unified across the team members and the organization unless there is a special case of license of capacity.



ETL Characteristics

- Successful ETL design have the following characteristics:



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 - ✓ Reliable.
 - ✓ Resilient.
 - ✓ Secure.



- To implement the previous characteristics you need to have the following:



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 - ✓ Logging.



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 - ✓ Atomicity.
 - ✓ Error Handling.
 - ✓ Managing Bad Data (Rejection Handling).



- Logging



ETL Logging

- Logging
 - Logging.



ETL Logging

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 - Logging.



- Logging
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ETL Data Lineage

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ETL Data Lineage

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- Logging



ETL Modularity

- Logging
 - Logging.



- Logging
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 - Logging.



- Logging
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 - Logging.
 - Logging.



- Logging



ETL Atomicity

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ETL Error Handling

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ETL Rejection Handling

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ETL Rejection Handling

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ETL vs ELT When? Why?



Sub-Section: Storage layer





Sub-Section: Logical layer





Sub-Section: Reporting (UI) layer





Sub-Section: Metadata layer





Sub-Section: System operations layer



System operations layer



DWH Architecture Overview

There are mainly three types of Datawarehouse Architectures: -

- Single-tier architecture.
- Two-tier architecture.
- Three-tier architecture.



Section: File Formats

- Any Big Data solution working based distributed systems.



File Formats

- Any Big Data solution working based distributed systems.
- What is distributed systems in brief?



Section: Data Encoding and Formats

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Section: Data Compression Technique



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Section: Data Archiving and Retention

Data Archiving and Retention

- some details about hot vs cold storage,



Section: DWH On Cloud



Section: Further Readings and Assignment