(Big) Data Engineering In Depth

From Beginner to Professional

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The Definitive Guide to Big Data Engineering Tasks

Videos classification

Watching Method / Audience	Computer	Mobile/Tablet	Just listening
Developer			🔵
DevOps			🔵
Business			🔵

Table: Video classification
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Chapter: Introduction To Data Management and Data Warehouse

Chapter Objectives

- Be familiar with data management life-cycle.

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- What are the data modeling and its design?

Section: Data Management

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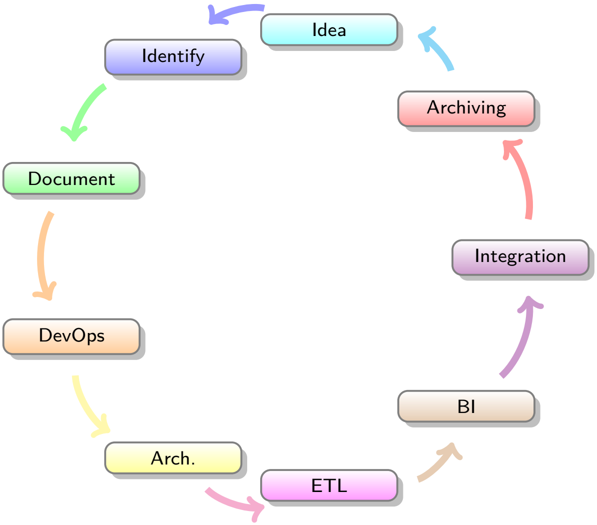
  - Data retention or **archiving** process ex: (Hot or Cold storage).

Data Management Life-Cycle



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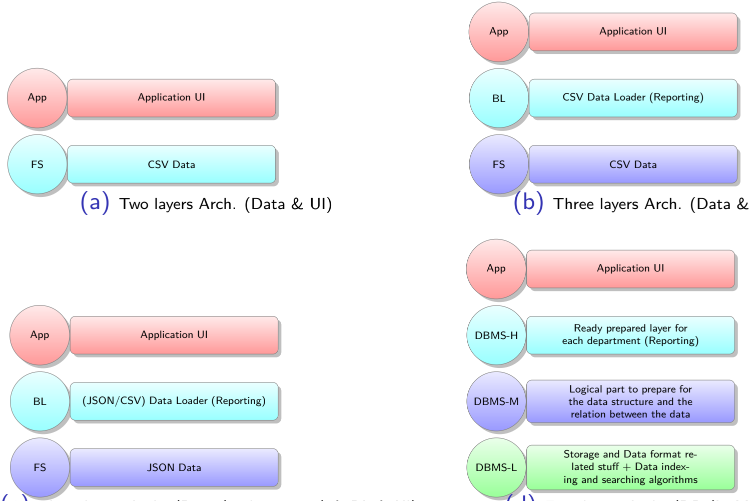
Section: Data Abstraction

Motivation to Data Layers (Use Case)



App — Application UI

FS — CSV Data

(a) Two layers Arch. (Data & UI)

App — Application UI

BL — CSV Data Loader (Reporting)

FS — CSV Data

(b) Three layers Arch. (Data & BL & UI)

App — Application UI

BL — (JSON/CSV) Data Loader (Reporting)

FS — JSON Data

(c) Three layers Arch. (Data (multi-sources) & BL & UI)

App — Application UI

DBMS-H — Ready prepared layer for each department (Reporting)

DBMS-M — Logical part to prepare for the data structure and the relation between the data

DBMS-L — Storage and Data format related stuff + Data indexing and searching algorithms

(d) Four layers Arch. (DB (L, M, H) & UI)

Figure: Data Abstraction Journey

Motivation to Data Layers (Solution Thinking)

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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**.

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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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  - Logical/Conceptual Level.
  - View Level.

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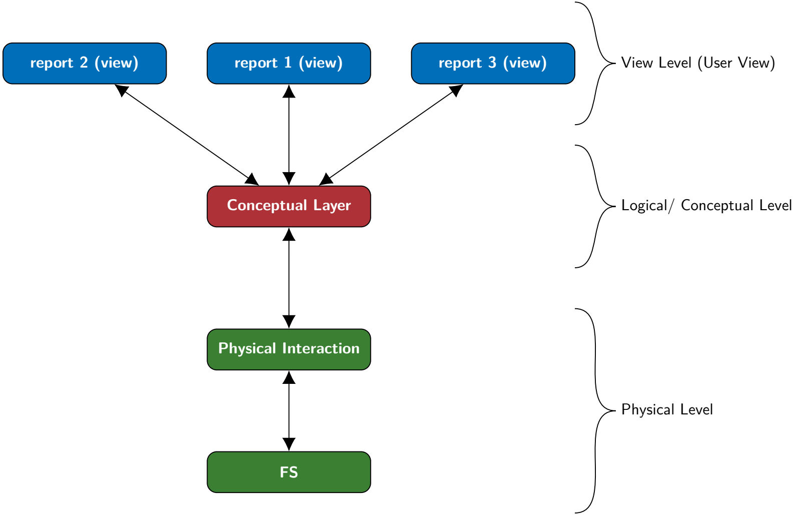

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    - Change the compression algorithm or hashing technique.

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    - The programmers' design this level based on business knowledge and the requirements

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  - 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

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Data solution thinking (Summary)

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

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    - When we need to add/remove/create new reports, it is usually a view layer.
    - We don't need to change the logical or physical layer to support the view layer.

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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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  - Physical Layer
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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.

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Sub-Section: Motivation to the Data Warehouse (DWH)

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  - Integration,
  - and Applying analytical functions.
- Vendors who are working on solving the above challenges are creating their product of DWH. Their ultimate goal is to optimize the above points.

Motivation to the Data Warehouse (DWH)

Definition (What is Data Warehousing?)

A DWH is 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.

Inmon Bill gave the real concept. He is considered the 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 built for data analysis and reporting.

Motivation to the Data Warehouse

Other names for the Data warehouse system:

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

Videos classification

Watching Method / Audience	Computer	Mobile/Tablet	Just listening
Developer		●	
DevOps		●	
Business		●	

Table: Video classification
The green circle ● means short video.
The blue circle ● means medium video.
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Sub-Section: Differences Between DWH and Operational DB

DWH vs Operational databases

Metric	**Transactions DB**	**DWH**
Volume	GB/TB	TB/PB
Historical	Short-term	Long-Term
rows	<1000M	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	Centeralized storage (360°)

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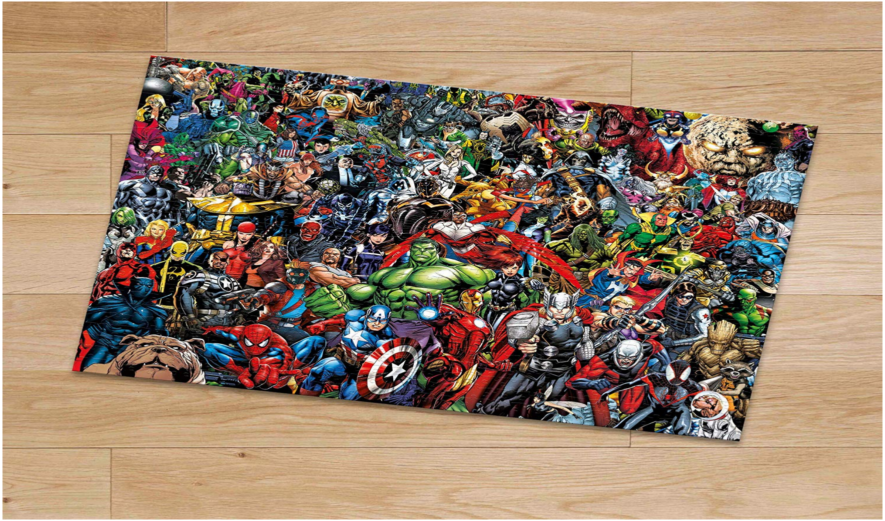
Transactional DB Use cases

Transactional DB Use cases

DWH Use cases

DWH Use cases



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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

Use case (Operational DB)

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  - Product owner can take a decision based on their system backend reports.

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    - 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.

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  - 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).

Use case (ODS)

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- ODS uses the real-time aggregations to support the online systems from different source systems.

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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).*

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Section: Hot vs Cold Storage

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SOME DETAILS HERE

Section: DWH Architecture

DWH Architecture Layers

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    - Reporting (UI) layer.
    - Metadata layer.
    - System operations layer.

DWH Architecture Overview

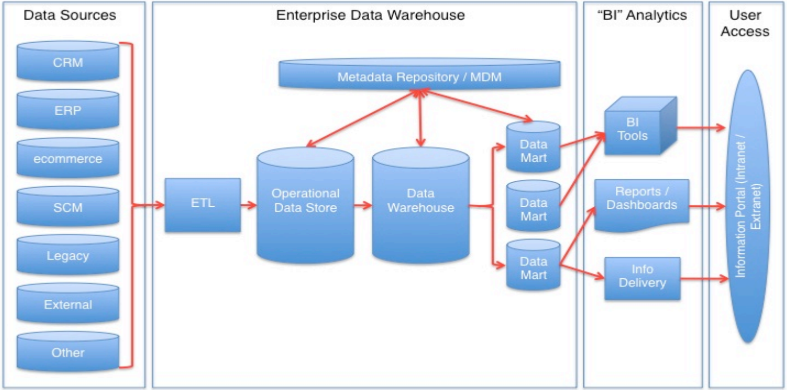

Figure: taken from

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.

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Sub-Section: Data Modeling

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- We will not go in details about how to design in this part (we will explain it later and in the appendix).

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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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- 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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Data Model Design vs Implementation

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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

What is ETL?

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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

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ETL Characteristics

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  - ☑ Maintainable.

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

ETL Logging

- Logging

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- Logging
    - Logging.

ETL Logging

- Logging
  - Logging.
  - Logging.

ETL Logging

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL Auditing

- Logging

ETL Auditing

- Logging
    - Logging.

ETL Auditing

- Logging
  - Logging.
  - Logging.

ETL Auditing

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL Data Lineage

- Logging

ETL Data Lineage

- Logging
  - Logging.

ETL Data Lineage

- Logging
    - Logging.
    - Logging.

ETL Data Lineage

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL Modularity

- Logging

ETL Modularity

- Logging
  - Logging.

ETL Modularity

- Logging
    - Logging.
    - Logging.

ETL Modularity

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL Atomicity

- Logging

ETL Atomicity

- Logging
    - Logging.

ETL Atomicity

- Logging
    - Logging.
    - Logging.

ETL Atomicity

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL Error Handling

- Logging

ETL Error Handling

- Logging
    - Logging.

ETL Error Handling

- Logging
  - Logging.
  - Logging.

ETL Error Handling

- Logging
    - Logging.
    - Logging.
    - Logging.

ETL Rejection Handling

- Logging

ETL Rejection Handling

- Logging
  - Logging.

ETL Rejection Handling

- Logging
    - Logging.
    - Logging.

ETL Rejection Handling

- Logging
  - Logging.
  - Logging.
  - Logging.

ETL vs ELT When? Why?

Sub-Section: Storage layer

Storage layer

Sub-Section: Logical layer

Logical layer

Sub-Section: Reporting (UI) layer

Reporting (UI) layer

Sub-Section: Metadata layer

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

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