

# (Big) Data Engineering In Depth

## From Beginner to Professional

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<sup>1</sup>Big Data & Analytics Department, Epam Systems

## The Definitive Guide to Big Data Engineering Tasks

# Course Introduction

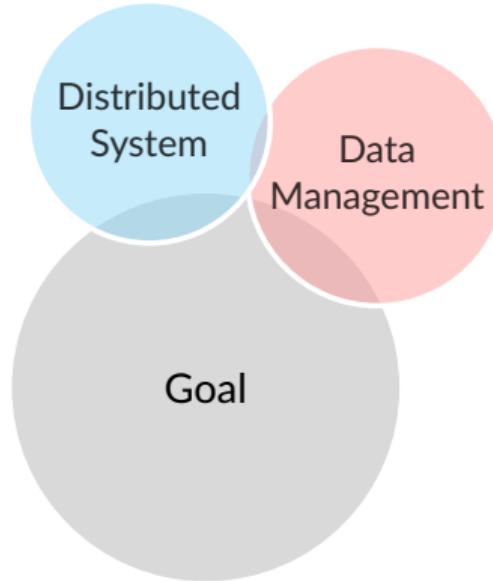
# Course Target



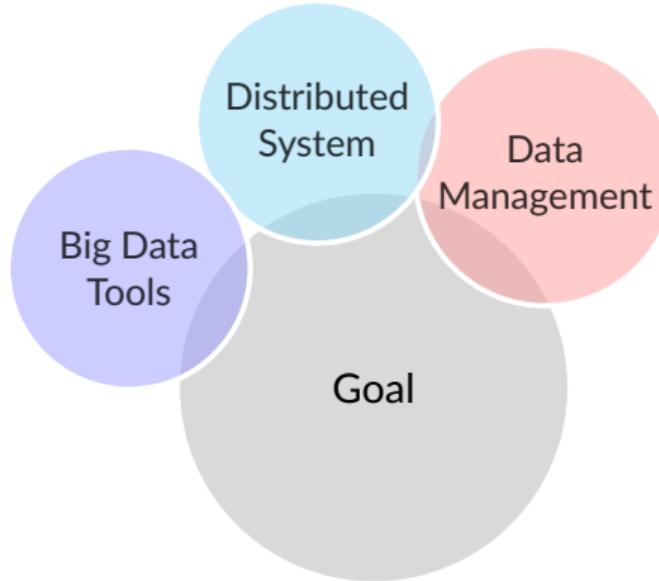
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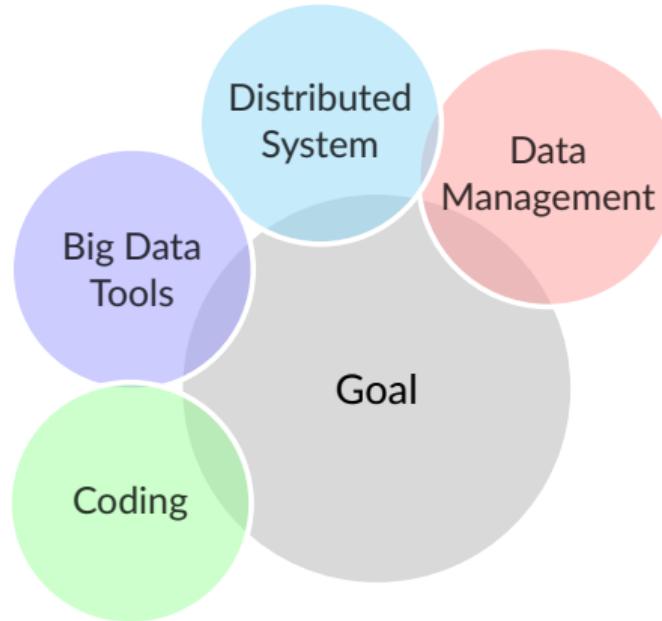
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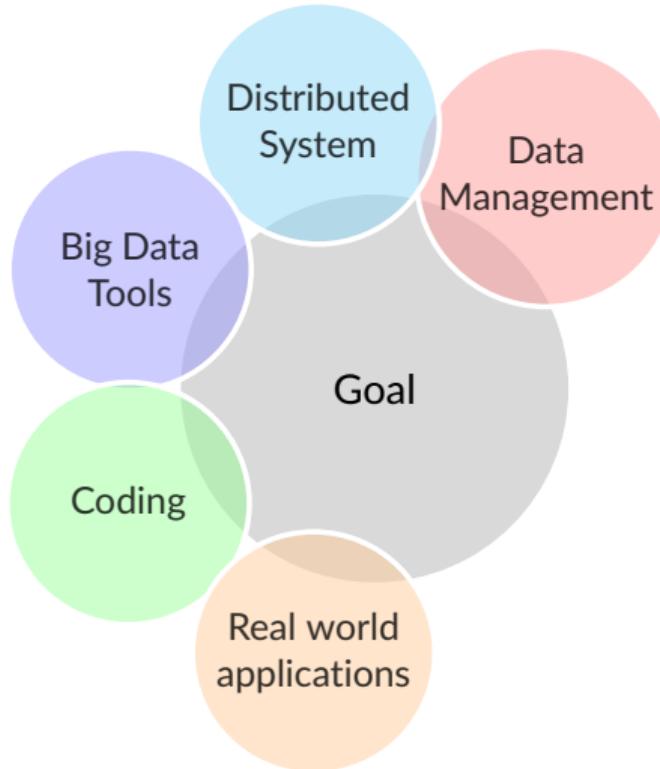
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## Learning Objectives and Audience

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# Videos classification

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

Table: Video classification

The green circle ● means short video.

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- Business or entrepreneur who needs to get more information about how to build or manage a data product.

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- Join online meetings or discussions.

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⚠ You MUST finish the red chapters first

Ch.01 Introduction

🔔 Finish colored groups  
before moving to the next group.

Ch.02 Data Management

Ch.03 Distributed Systems

Ch.04 Hadoop and MR

Ch.05 FN and Scala

Ch.06 Spark

Ch.07 Big Data Application

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## Assignments, Labs, and Text Books

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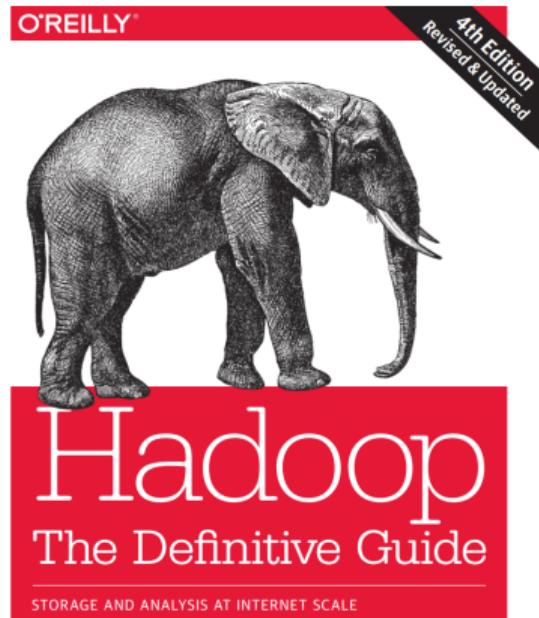
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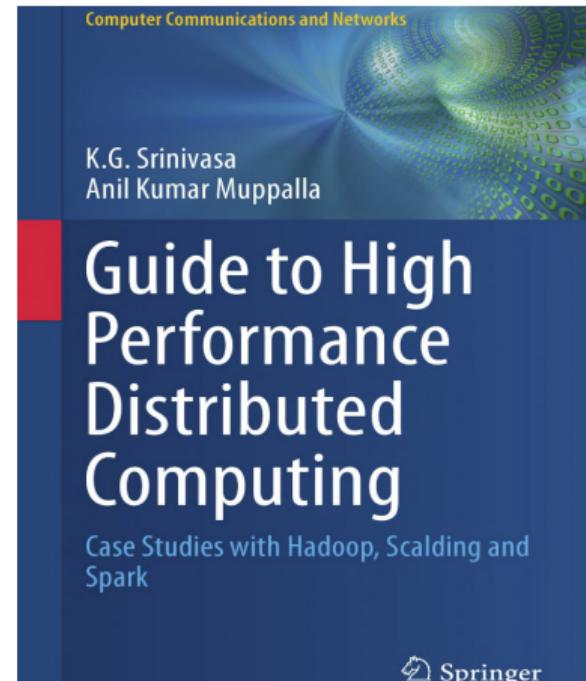
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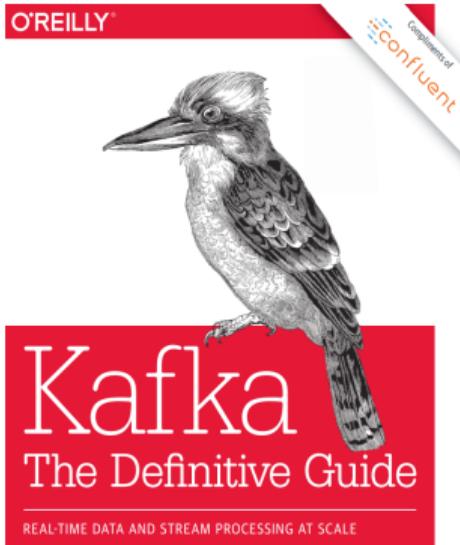
Tom White



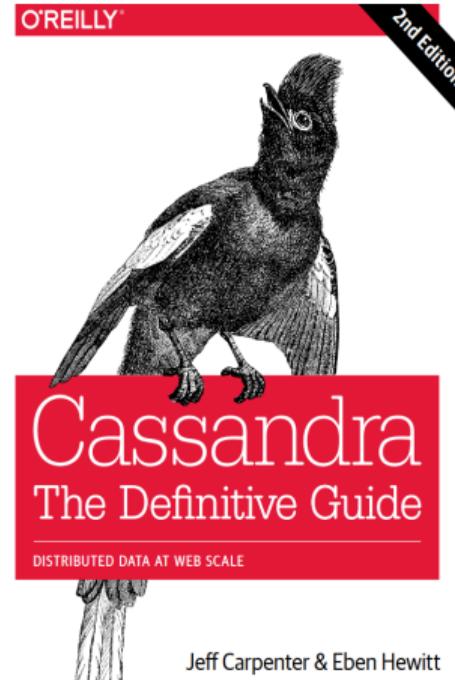
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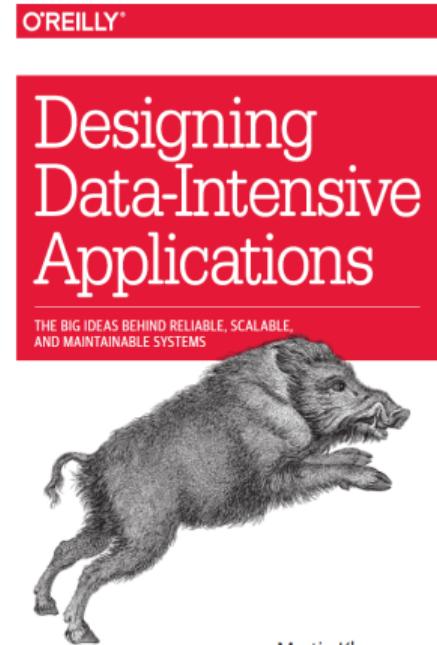
# Textbooks-3



Neha Narkhede,  
Gwen Shapira & Todd Palino



Jeff Carpenter & Eben Hewitt



Martin Kleppmann

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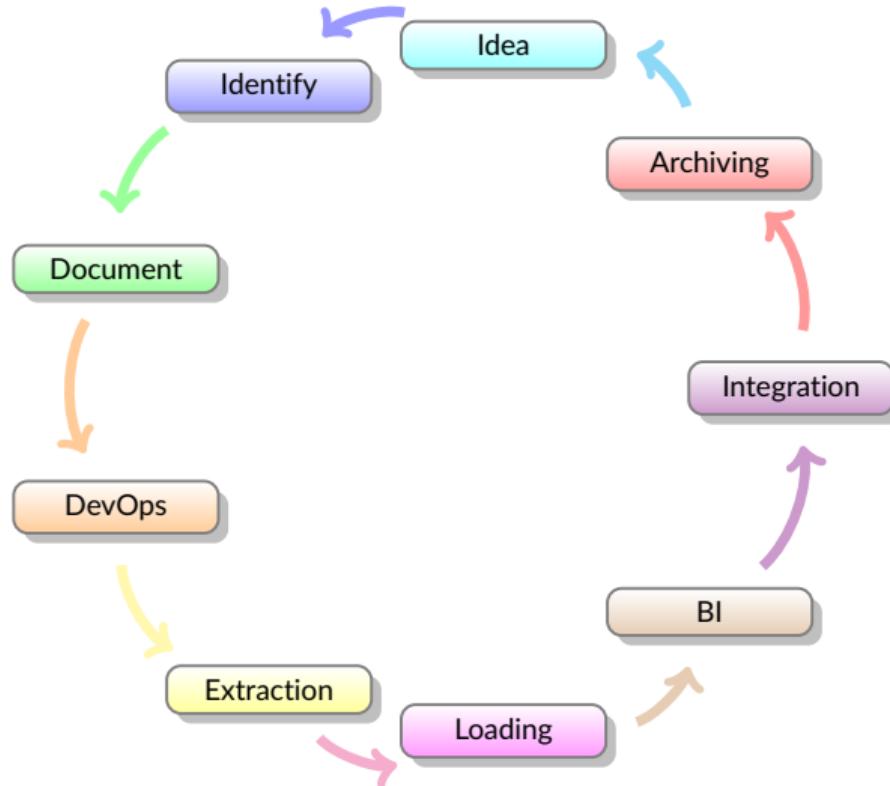
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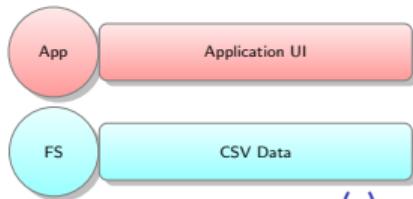
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# Data Management Life-Cycle

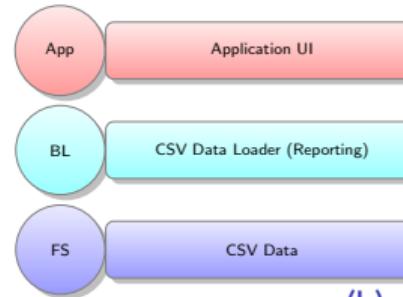


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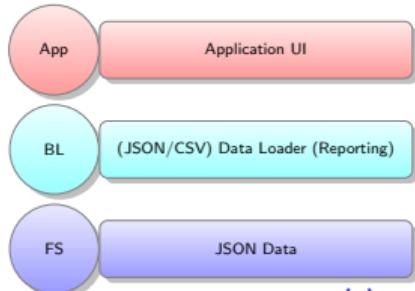
# Motivation to Data Layers (Use Case)



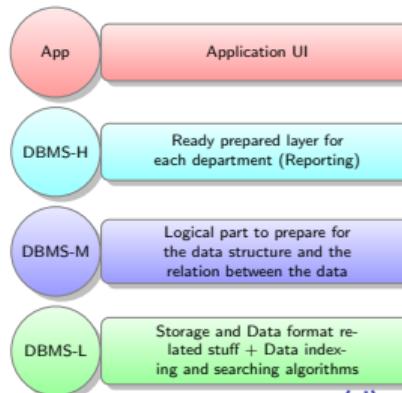
(a) Network 1



(b) Network 2



(c) Network 3



(d) Network 4

Figure: The average and standard deviation of critical parameters: Region R4

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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 developer (user) is called data abstraction.

## Definition

**Data Abstraction and Data Independence:** DBMS comprise of complex data-structures. In order 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.

- There are 3 levels of data abstraction.

# Data Layers (Abstraction)

## Definition

**Data Abstraction and Data Independence:** DBMS comprise of complex data-structures. In order 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.

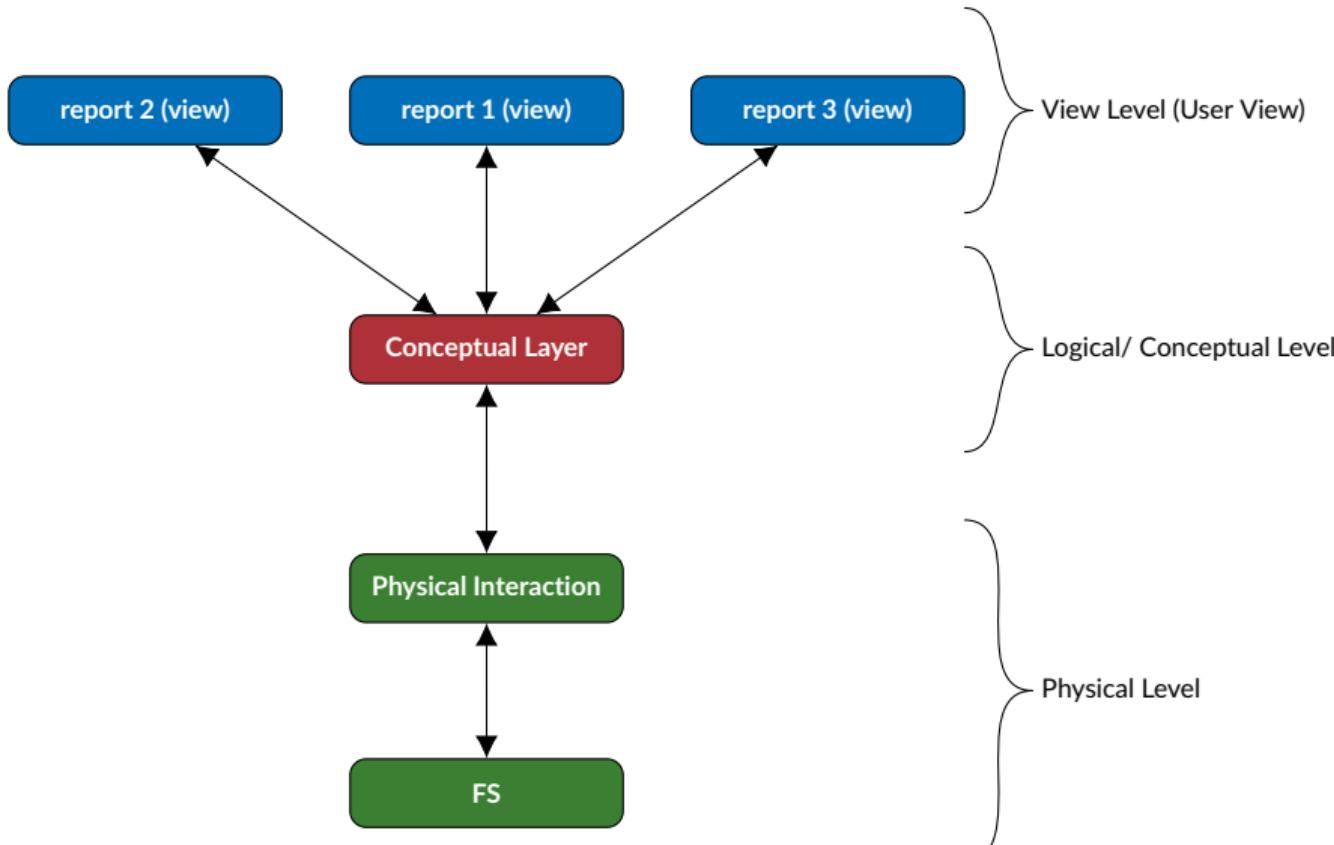
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  - Physical Level
  - Logical/ Conceptual Level.
  - View Level.

# Data Layers (Abstraction)



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  - Change the compression algorithm or hashing technique.

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

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  - View of the data stored?
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  - Not all the views are extended to all users and there is an authentication based on the category.

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- Database contains product information.
- It could be designed to show the sales of product in specific region.
- 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?

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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 your storage/compression/structure/access technique.
    - 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.

# Introduction to DWH

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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.

## Differences Between DWH and Operational DB

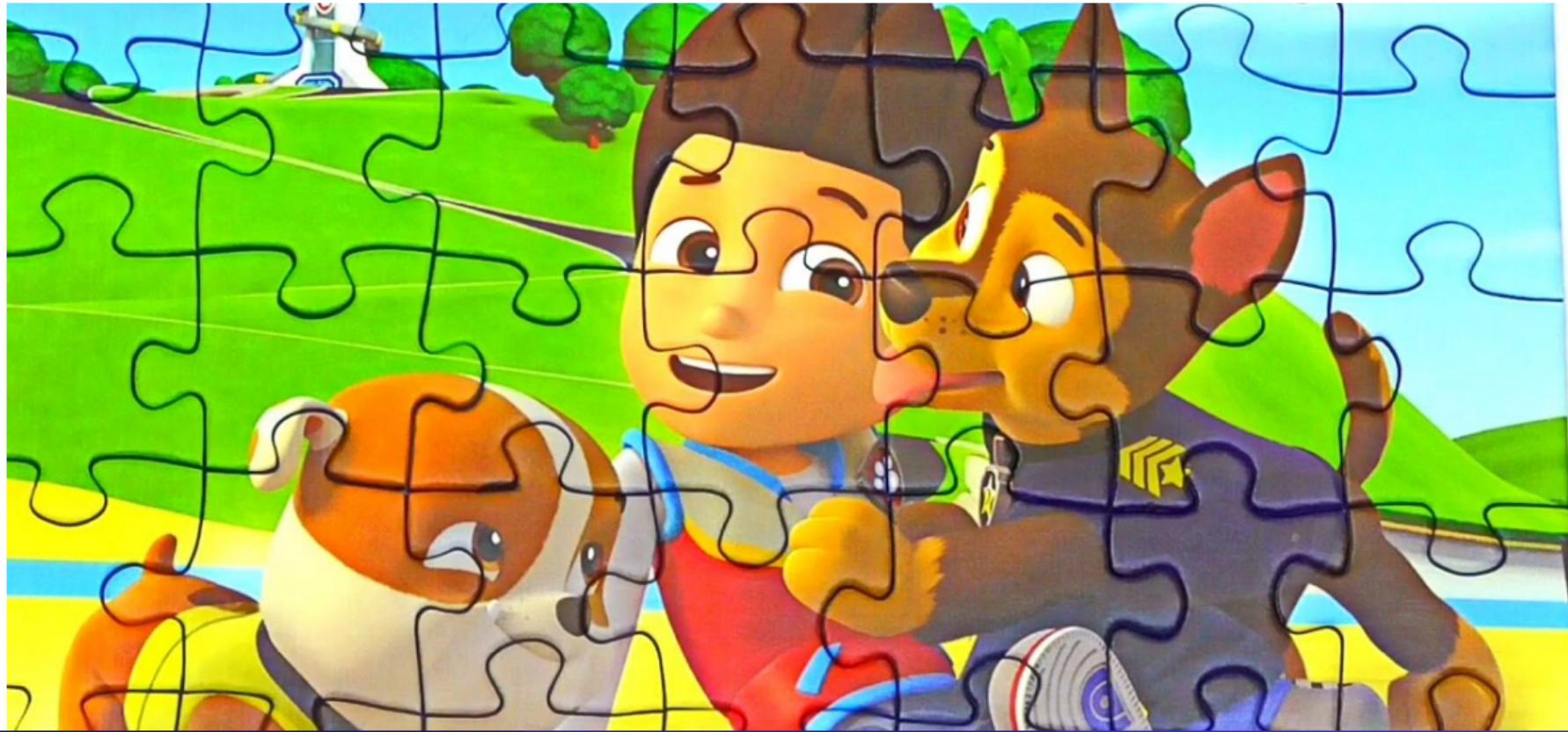
# DWH vs Operational databases

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



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# DWH Use cases



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# DWH Use cases



# 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

## Use Cases of Operational DB vs DWH

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  - 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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  - The decision from the DWH 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?

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- 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 inquiries.

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  - It requires to track the source system database changes or update in real-time.
  - Its 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 uses the real-time aggregations to support the online systems from different source systems.

# DWH Characteristics

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- 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).*

# DWH Architecture

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  - Metadata layer.
  - System operations layer.

# DWH Architecture Overview

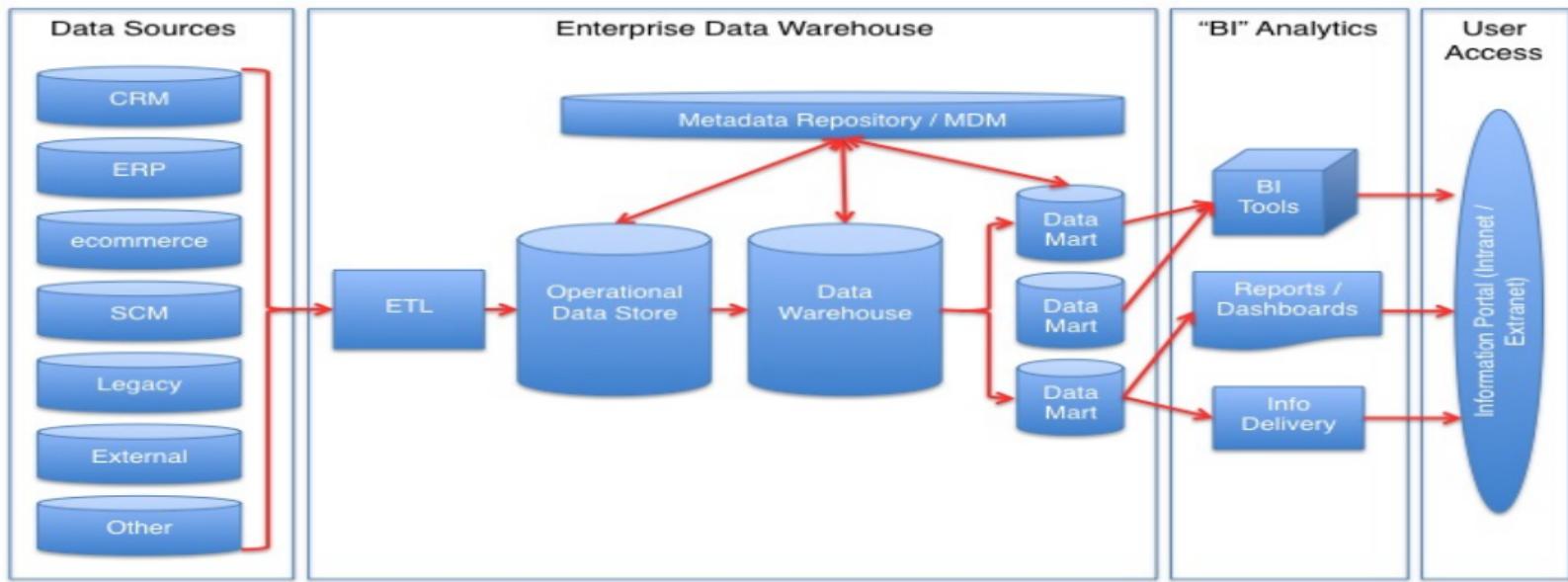


Figure: taken from XXXX

# ETL Process

## ETL vs ELT When? Why?

# Data Models

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

# What is data model?

Data model is not

- a science.
- a static design for each organization.
- a type of database.
- a new invention which needs to be done for each project.

Data model is

- an engineering design practices.
- a general concepts which lead to build full architecture.
- different based on the use case and the database type.
- customizable and we can utilize some of ready built architecture.
- implementing using different ways.
- affecting the information reporting performance and ways.

# 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

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  - Decide the decorations, colors for each room, carpets, etc.

# Data Model Design vs Implementation

- You need to build a home. So, how do we design this home?
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  - Hire an architect to put the architecture in more detailed way for example, the size for each room, the distribution of the wireds, where the plumbing fixtures will be placed, etc. (Architecture phase)
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  - 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)

# DWH Architecture Overview

There are mainly three types of Datawarehouse Architectures: -

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

# File Formats

# Data Models

- Any Big Data solution working based distributed systems.

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- What is distributed systems in brief?

# Data Encoding and Formats

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# Data Compression Technique

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# Data Archiving and Retention

# Data Models

- some details about hot vs cold storage,

# Different Types of Storage

# Cold storage vs Hot storage

some details about hot vs cold storage,

# DWH On Cloud

## Further Readings and Assignment