University of Minho
School of Engineering
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Big Data Warehouses: Solving Big Data Challenges with Innovative Techniques and Technologies

Carlos Costa

Data Science Portugal
DSPT#24 Meetup

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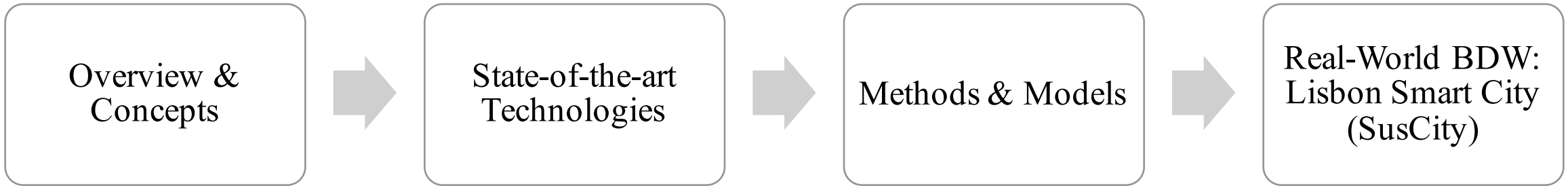
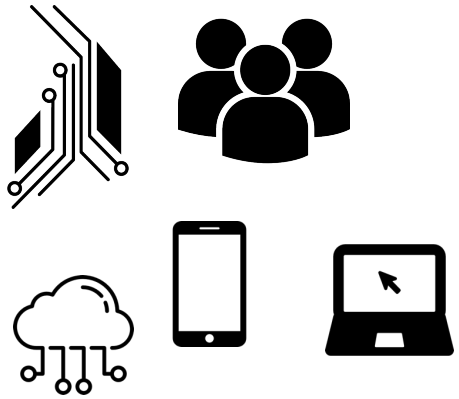
Outline


Overview & Concepts
State-of-the-art Technologies
Methods & Models
Real-World BDW: Lisbon Smart City (SusCity)

Overview & Relevance of Big Data

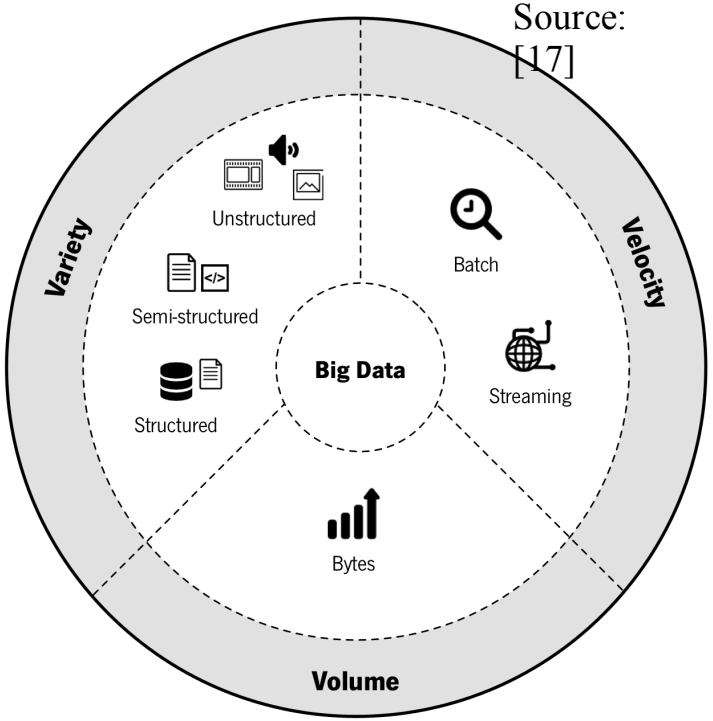
Overview & Relevance of Big Data



↑ Information Technology (IT)

+ Advancements & Use

Source: [17]

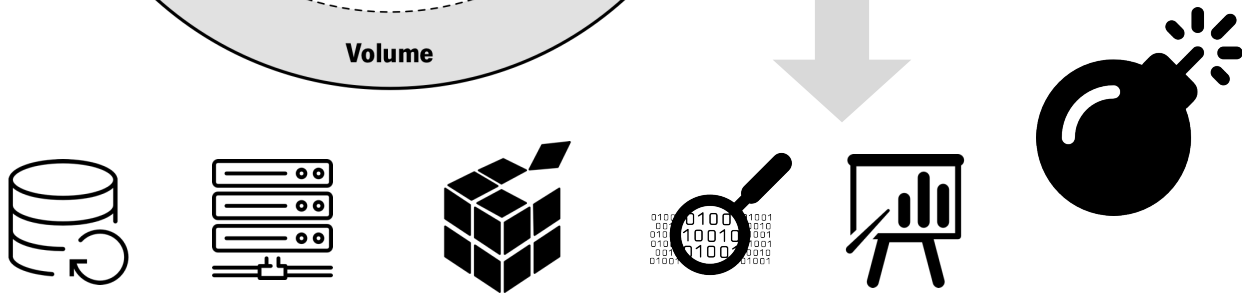


+ Data Volume

+ Variety

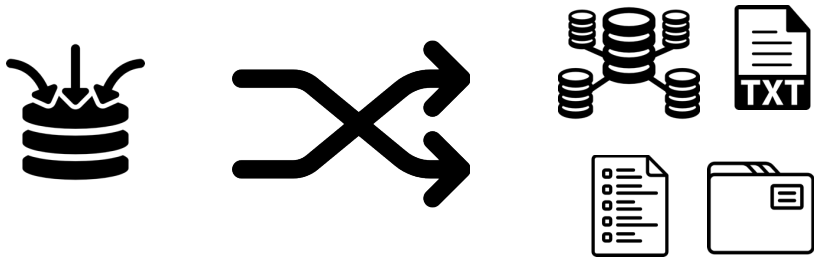
+ Velocity

= **Big Data**



- **Extraction, Storage, Processing & Analysis**
- Challenging for traditional techniques and technologies

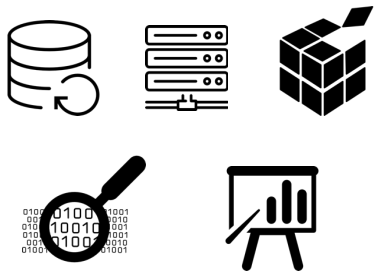
Overview & Relevance of Big Data



- Big Data = Paradigm Shift
- Not only a **Buzzword!**

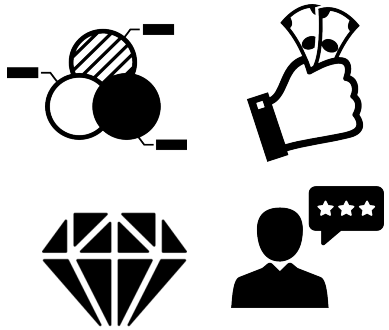
- More Insightful **analysis**
- Challenging and Granular **sources**
- **Advanced techniques** to extract value and respond to business changes [1]

Overview & Relevance of Big Data



Big Data Life Cycle

- Techniques
- Technologies



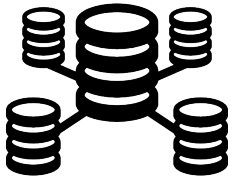
+ Efficiency
+ Products & Services
+ Value & Competitive Advantages

Health | Government | Retail | Manufacturing | Cities

[3][4]

Big Data Warehouse (BDW)

BDW: Introduction to the Concept



- The traditional Data Warehouse (DW)
  - Fundamental enterprise data asset
  - Supports fact-based decision-making in organizations [5]
  - Optimized for analytical tasks [6]

- Limitations in Big Data environments [7],[8],[9],[10]
  - Amount and characteristics of data
  - High frequency ingestion
  - Mixed and complex analytics

The community raised interest in BDWs

BDW: Introduction to the Concept

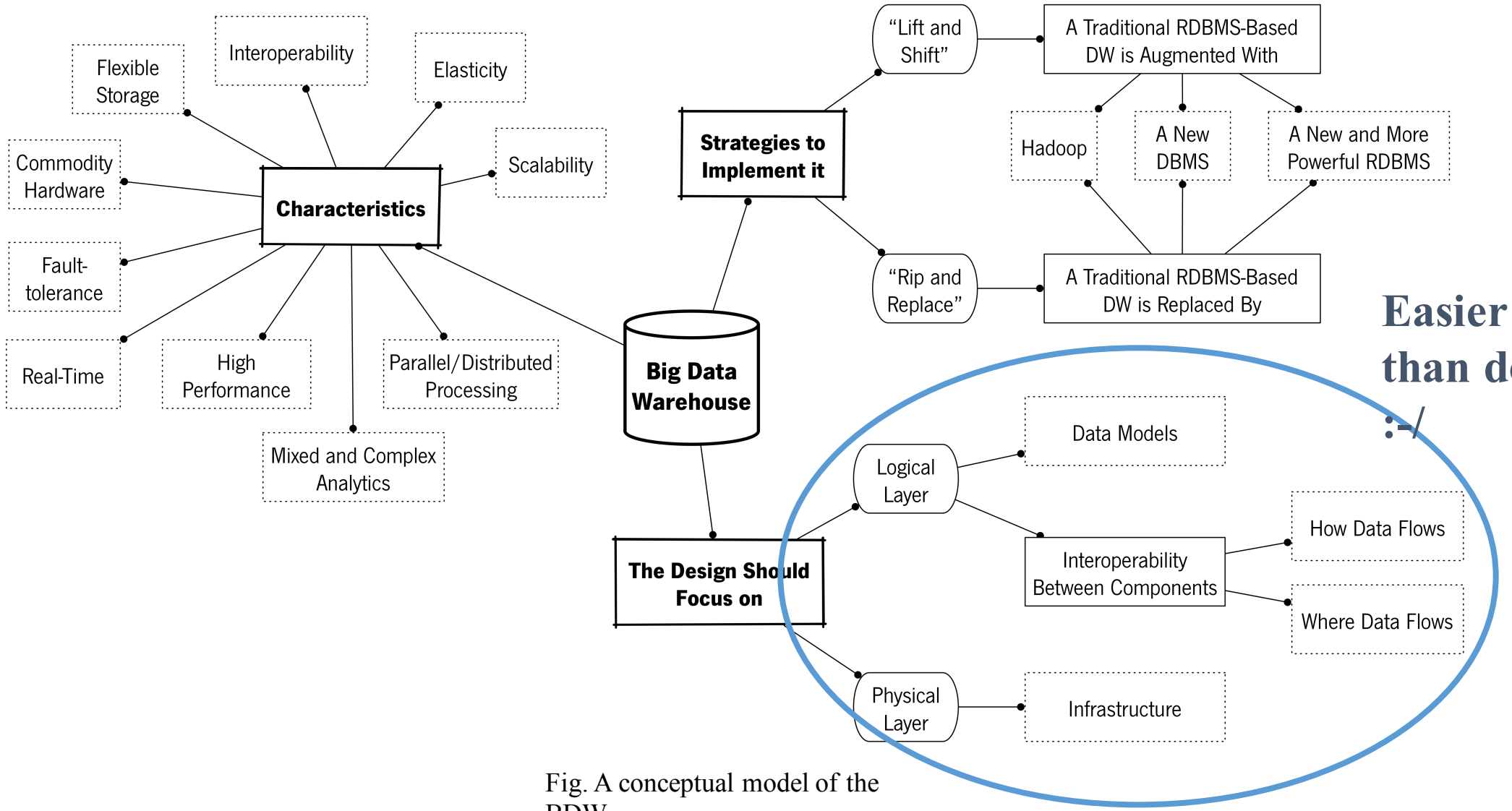
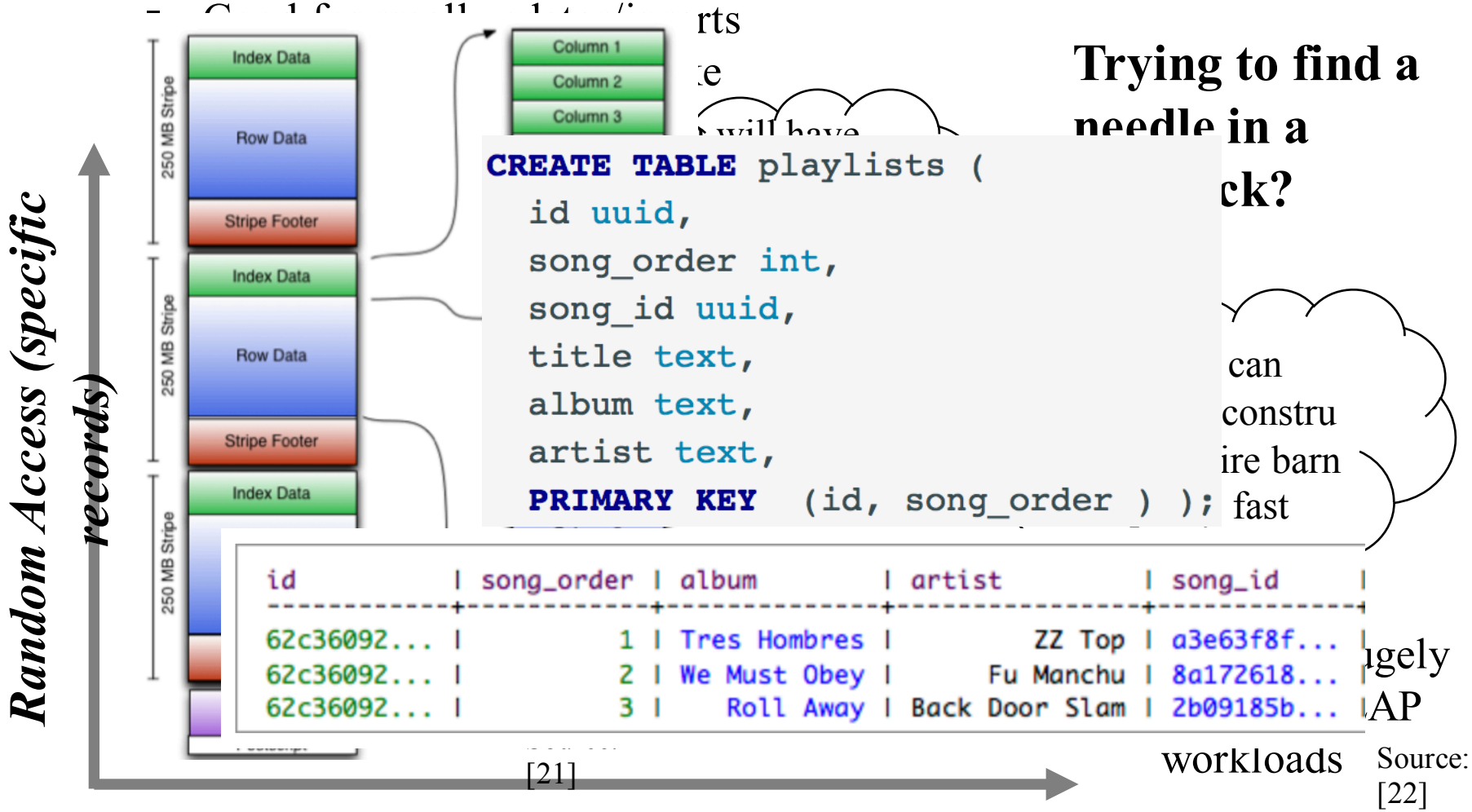


Fig. A conceptual model of the BDW.

BDW: Relevant Knowledge-Base → Technologies

Big Data Storage



[21]

Trying to find a needle in a ck?

can constru ire barn fast

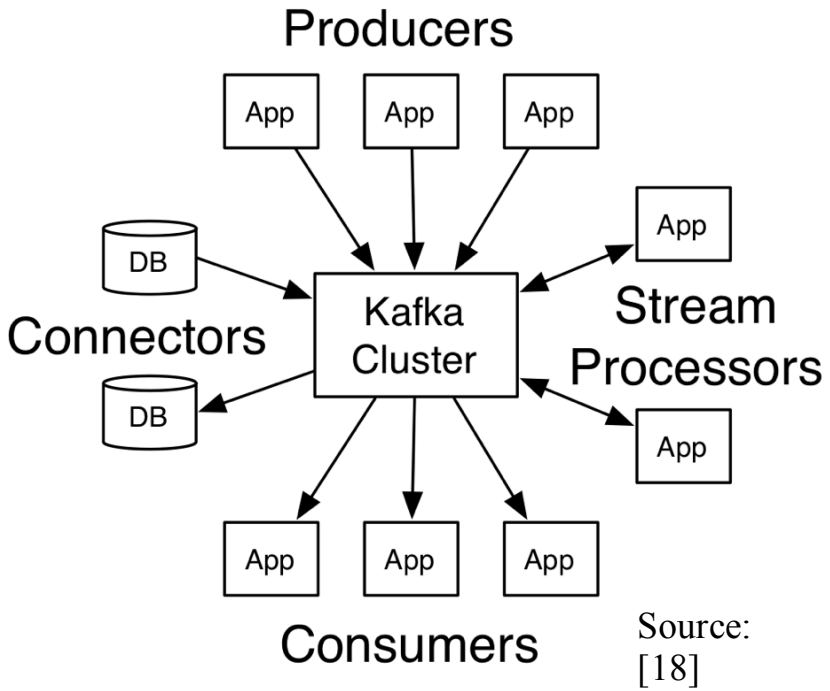
igely AP workloads

Source: [22]

BDW: Relevant Knowledge-Base → Technologies

Big Data Collection & Processing

- **Kafka**
- Publish & Subscribe system
- Produce and consume streams of data
- Scalable broker
- Real-time Event Analysis, Process Monitoring, Real-time Metrics/KPIs



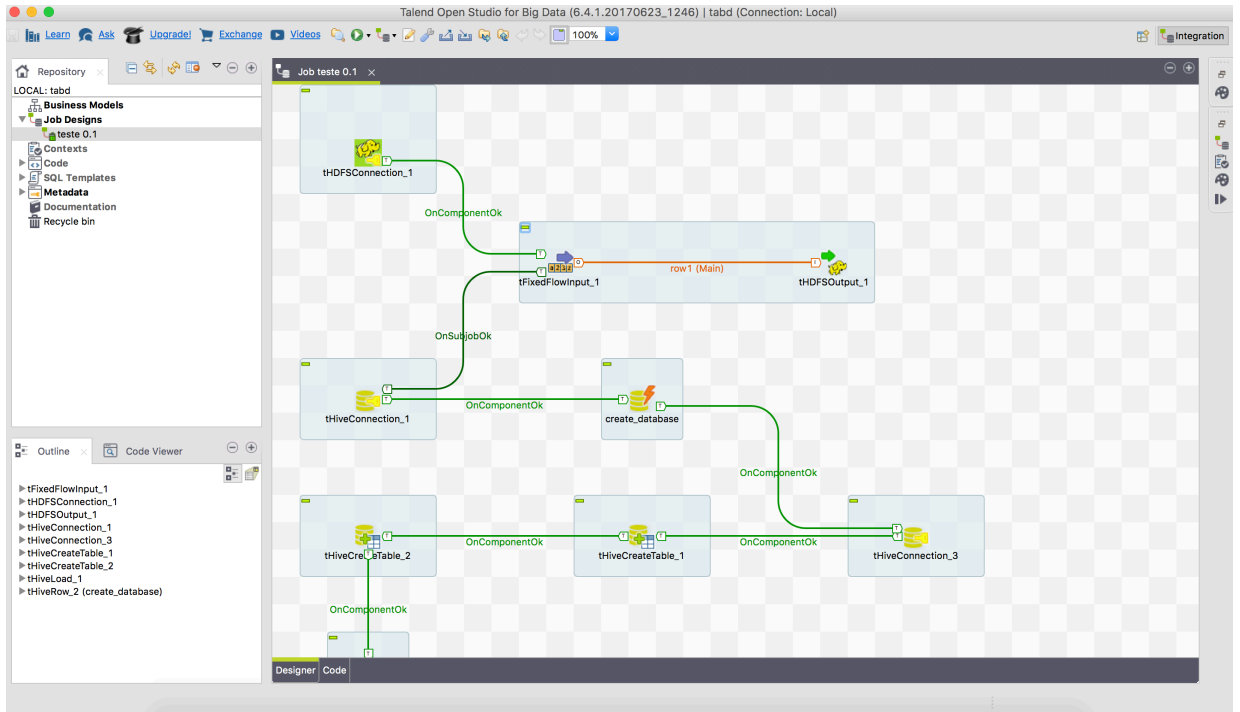
Source: [18]

BDW: Relevant Knowledge-Base → Technologies

Big Data Collection & Processing

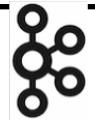
- **Talend Open Studio for Big Data**

- Single-server ETL tool
  - Lots of Big Data components
    - HDFS
    - Cassandra
    - HBase
    - Hive
    - ...
  - GUI environment, but lacks scalability

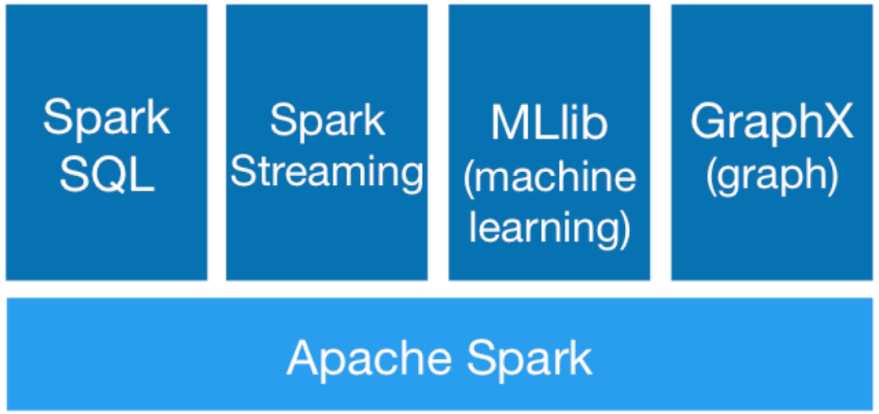


BDW: Relevant Knowledge-Base → Technologies

Big Data Collection & Processing



- Fast and general Big Data processing platform
  - Scalable ETL
  - Real-time ETL (w/ Kafka)
- DAG execution and in-memory computing (not exclusively)
- Very user-friendly Scala, Java, Python or R API

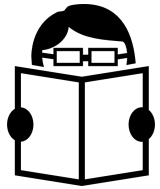


Source: [19]

SQL-on-Hadoop

- What is it?
  - Some inspiration from MPP databases and Google Dremel [20]
  - Bypass heavy coordination and resource scheduling tasks used by MapReduce
    - Ready-to-go daemons
  - Optimized query planner
  - Columnar file formats - ORC/Parquet

- Well, it's the distributed SQL-on-Everything
  - HDFS
  - Hive tables
  - NoSQL databases
  - SQL databases
- One query -> data from several sources
- A central piece for a BDW architecture
- Sub-second near real-time OLAP queries over GBs/TBs/PBs of data



Methods & Models for This Madness

Based on:
[16]

Approach: LOGICAL COMPONENTS AND DATA FLOWS

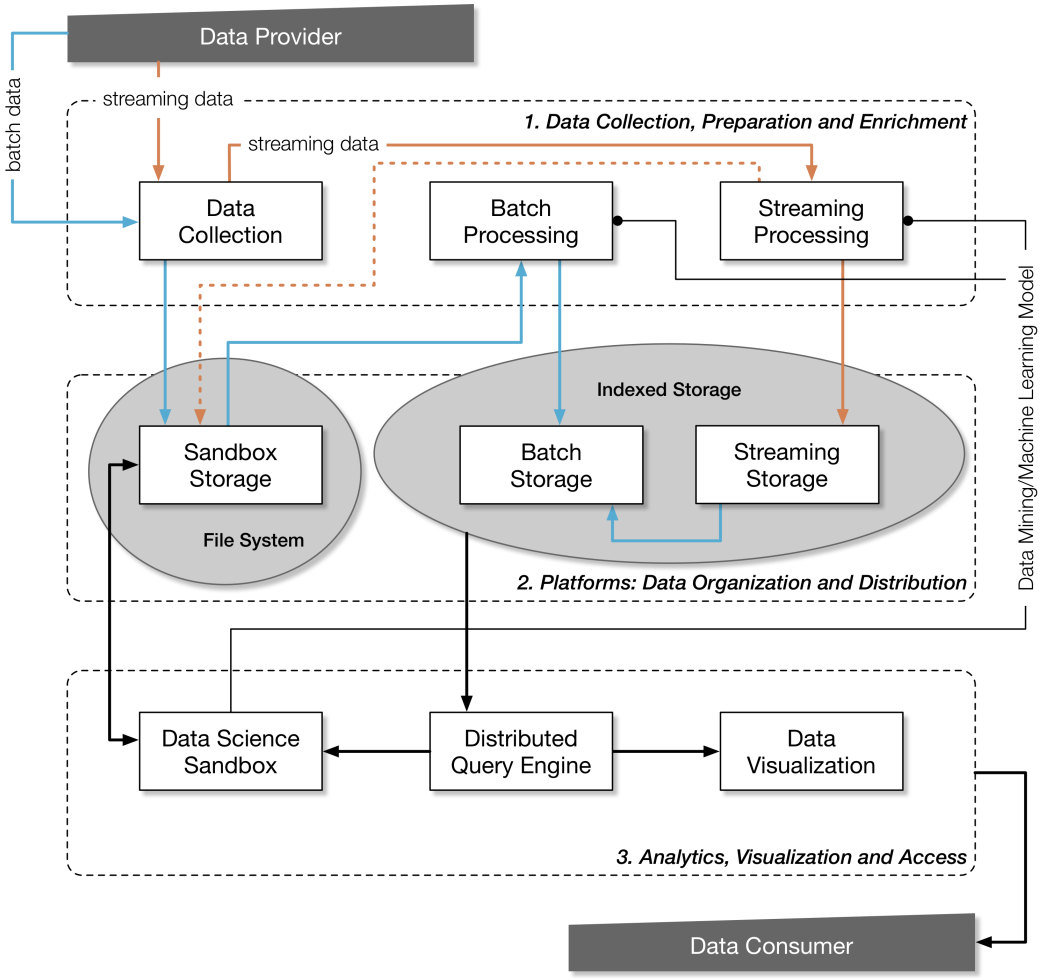


Fig. YADWA's model of logical components and data flows.
Source: [24]

Approach: PHYSICAL LAYER

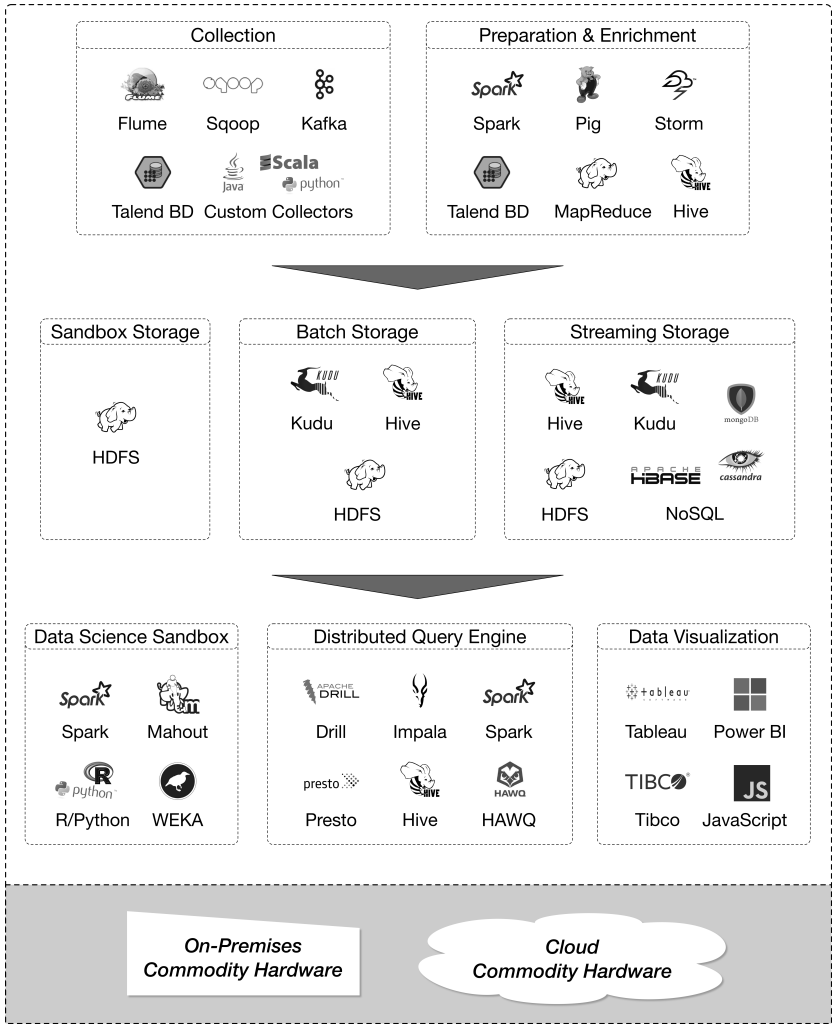


Fig. YADWA's model of the technological infrastructure.
Source: [24]

- Big Data Storage and Processing
  - **Hadoop**
  - **NoSQL**
  - **SQL-on-Hadoop**

Hortonworks

- Data Collection, M g,

ANSIBLE

Soon to launch!!

Ansible playbook to deploy simple and secure Hortonworks Hadoop, Presto and Cassandra clusters

https://github.com/epilif1017a

- **Shared-nothing architectures**
- **Scale-out** in favor of **Scale-up**

Approach: DATA MODEL

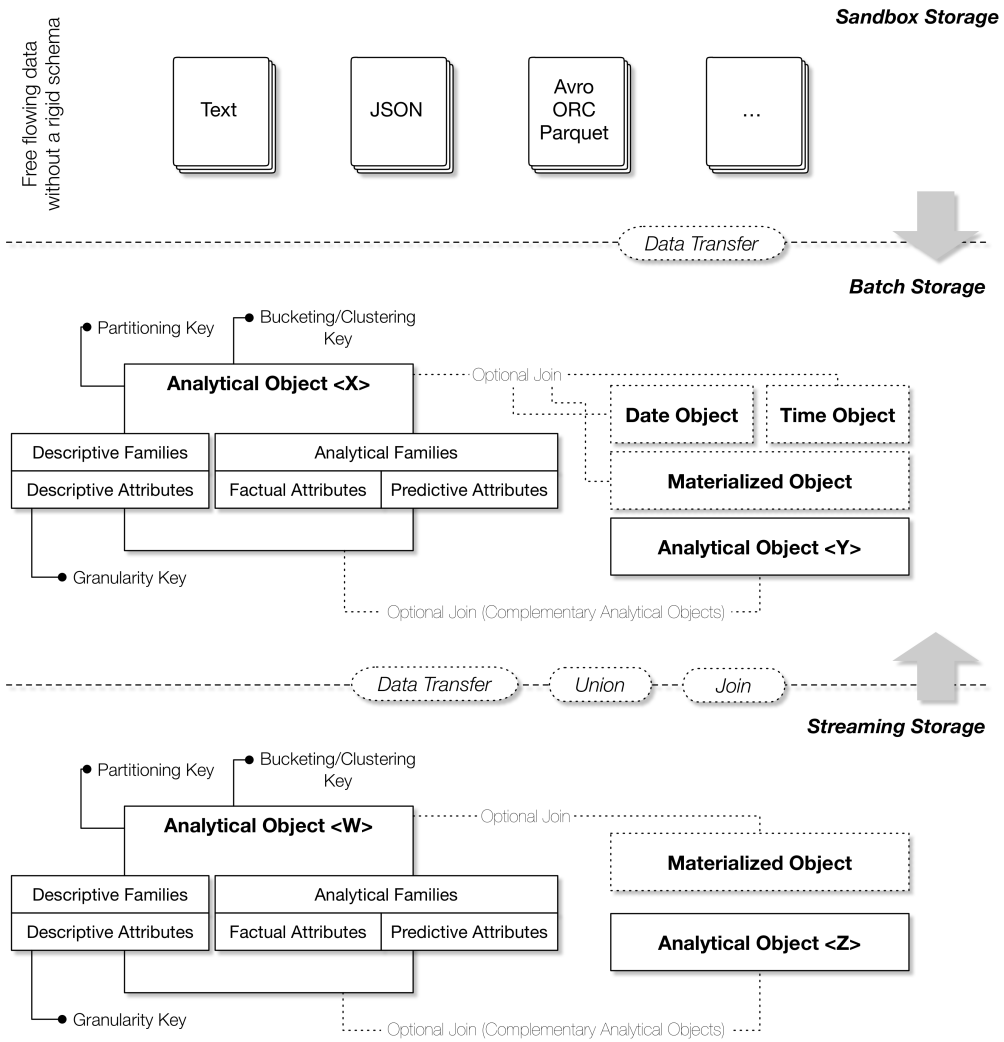


Fig. YADWA's data model. Source: [24]

- **Analytical Objects**
  - Flat/Denormalized structures
    - + performance + flexibility
  - Nested structures (e.g., arrays, maps)
  - **Descriptive attributes** = dimensions
  - **Analytical Attributes** = facts and predictions
- **Complementary Analytical Objects**
  - Small, low velocity, reusable data sources
  - If true → fast joins on SQL-on-Hadoop systems
- **Date, Time and Materialized Objects**
- Unified **Batch and Streaming**
  - Same modelling approach
  - Integrate both in the same query (SQL-on-Everything)

Approach: DATA MODEL

Fig. Performance comparison of data modelling strategies. Based on: [23].

Real-world BDW Application: SusCity MIT Portugal Project (Lisbon)

Real-world Applications: **BDWs on Smart Cities** (SusCity [15])

Removed due to confidentiality issues. See more in [15] and https://www.youtube.com/watch?v=sZiIwKj4BXc

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[24] Costa, C., Andrade, C., Santos, M.Y.: Big Data Warehouses for Smart Industries. In: Encyclopedia of Big Data Technologies. Springer (2018)

Further Reading

- https://www.researchgate.net/profile/Carlos_Costa60

- Includes:
  - Costa, C., Santos, M.Y.: The data scientist profile and its representativeness in the European e-Competence framework and the skills framework for the information age. International Journal of Information Management. 37, 726–734 (2017). doi:10.1016/j.ijinfomgt.2017.07.010

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